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From the Editors

We are pleased to begin the year with a collection of papers that are sure to be of interest to a wide readership. As ever, the range of subject matter included in this issue is a reflection of the natural world as a whole, as well as of the diverse interests of the journal and its readership.

Papers on aspects of the plant world (Meagher, Muller, Johnston, Hill and Pickering, White and Gibson); birds (Murphy, Overeem and Wallis); snakes (Clemann *et al.*); and fungi (Schleiger), together with reviews of recently published works in an equally-wide spectrum of areas, ensure that this issue caters to most tastes. The reviews may trend to books on various elements of vegetation, but there is also something on photography and history – all within the ambit of the natural world.

We were saddened by the sudden passing of a former President of the FNCV, Dr Jack Douglas, in February, and a tribute to him is included in the pages of this issue.

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Front cover: Sacred Kingfisher *Todiramphus sanctus*: a woodland bird species at risk of future decline. Photo by Michael Murphy. See p. 4.

Back cover: De Vis' Banded Snake *Denisonia devisi* from Wallpolla Island, north-western Victoria. Photo by Nick Clemann. See p. 33.

The bird communities of Berry Jerry State Forest and The Rock Nature Reserve near Wagga Wagga, New South Wales in 1975-1981 and 1995-2003

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Abstract

A study of the bird communities of two public reserves near Wagga Wagga on the NSW South Western Slopes recorded 127 species including 26 woodland species considered to be declining in the region (seven of which are currently listed as threatened under NSW state legislation) and 49 woodland species at risk of decline, as well as a range of agricultural species and waterbirds. Ninety-three species were recorded in Berry Jerry State Forest and 108 species in The Rock Nature Reserve, with 74 species found in both. Differences between the bird communities of the two reserves are in part a reflection of the different habitats available, with Berry Jerry State Forest supporting a diverse aquatic bird community in addition to the terrestrial bird community. Species in the 'declining' and 'at risk' categories made up approximately two thirds of the terrestrial bird communities of both reserves, and both reserves are considered to be close to losing a number of these species. Comparison of records from 1995-2003 and 1975-1981 suggests that Berry Jerry State Forest may have lost four species of its declining woodland bird community (Speckled Warbler *Chthonicola sagittata*, Eastern Yellow Robin *Eopsaltria australis*, White-browed Babbler *Pomatostomus superciliosus* and Diamond Firetail *Stagonopleura guttata*) over the past two decades. Both Berry Jerry State Forest and The Rock Nature Reserve are considered to be of regional significance for bird conservation. A combination of local- and regional-scale management actions is necessary if they are to maintain viable bird communities. (*The Victorian Naturalist* **124** (1), 2007, 4-18).

Introduction

The New South Wales (NSW) South Western Slopes Biogeographic region (Thackway and Creswell 1995), in inland southeastern Australia, has been extensively modified over approximately 18 decades of European occupation to become one of Australia's primary agricultural and pastoral regions. An estimated 84% of the region's original temperate woodland and forest has been cleared (Pressey *et al.* 2000) and the modern landscape is a variegated patchwork of cropped areas, grazing lands of native or improved pasture (with or without scattered senescent trees) and small woodland/forest remnants, typically on poorer soils (Morgan and Terrey 1992; Sivertsen 1993; Murphy 1999; Gibbons and Boak 2002). Together with other parts of southern Australia's sheep-wheat belt, the region today faces serious issues of declining agricultural productivity (through processes such as soil erosion and salinity) and declining biodiversity (Saunders 1994; Robinson and Traill 1996; Barrett 1997; Reid 1999).

While some native bird species such as the Crested Pigeon *Ocyphaps lophotes*, Galah *Cacatua roseicapilla*, Noisy Miner *Manorina melanocephala* and Australian Magpie *Gymnorhina tibicen* are able to survive or even thrive in the modern agricultural landscape of southern Australia's sheep-wheat belt (Grey *et al.* 1997; Recher 1999; Reid 1999), many others depend wholly or in part on the remaining remnants of the original vegetation. Recent studies and reviews have indicated that a large proportion of the birds dependent on Australia's temperate woodlands is in rapid decline with a continuing wave of local and regional extinctions (Saunders 1989; Barrett *et al.* 1994; Robinson and Traill 1996; Reid 1999; Traill and Duncan 2000). Robinson and Traill (1996) estimated that more than one quarter of all terrestrial bird species found in Australia's temperate woodland regions were currently affected. Threatening processes driving this ongoing decline include a combination of continued clearing of remnant woodland habitat, extinction debt (where relictual populations isolated in remnants too small to sustain them decline over time to eventual local extinction) and ongoing degradation and disturbance of remnant areas

Apostlebird *Struthidea cinerea*: a declining woodland bird species. Photo by Michael Murphy.

through over-grazing by domestic stock, weed invasion, increased predation or competition by feral animals or disturbance-tolerant native species, firewood collection, pollution with agricultural chemicals, tree dieback and inappropriate fire regimes (Ford 1985; Saunders 1989; Benson 1991; Robinson and Traill 1996; Traill and Duncan 2000).

Only about 1% of the NSW South Western Slopes region has been set aside in formal conservation reserves (State of the Environment Advisory Council 1996; Pressey *et al.* 2000), and additional areas of remnant native vegetation occurring on freehold properties and on public lands such as state forests and travelling stock reserves make a significant contribution to supporting regional biodiversity. The present study examined the local bird communities occurring in two public land woodland/forest remnants on the NSW South Western Slopes; one a formal conservation reserve and the other a state forest. The results from the present study were also compared with information from a similar study two decades earlier. Studies such as this are useful in providing a local, site-specific perspective to regional-scale patterns of change in bird communities.

Methods

Study areas

The two study areas (Figs 1-3) were Berry Jerry State Forest (SF) and The Rock Nature Reserve (NR), near Wagga Wagga in Wiradjuri Aboriginal Country in the NSW South Western Slopes bioregion.

Berry Jerry SF (35° 03'S, 147° 03'E), dedicated in 1915 and currently 1199 ha in area, is managed by Forests NSW (now part of the NSW Department of Primary Industries). It is located approximately 25 km west of Wagga Wagga on alluvial soils of the Murrumbidgee River floodplain. Beavers Creek (an anabranch of the Murrumbidgee River) runs through the reserve and, together with associated wetlands, provides extensive aquatic habitat. The vegetation of the reserve is predominantly riverine forest of River Red Gum *Eucalyptus camaldulensis* with an understorey of grasses and herbs. Large mature trees with abundant hollows are common along the banks of Beavers Creek.

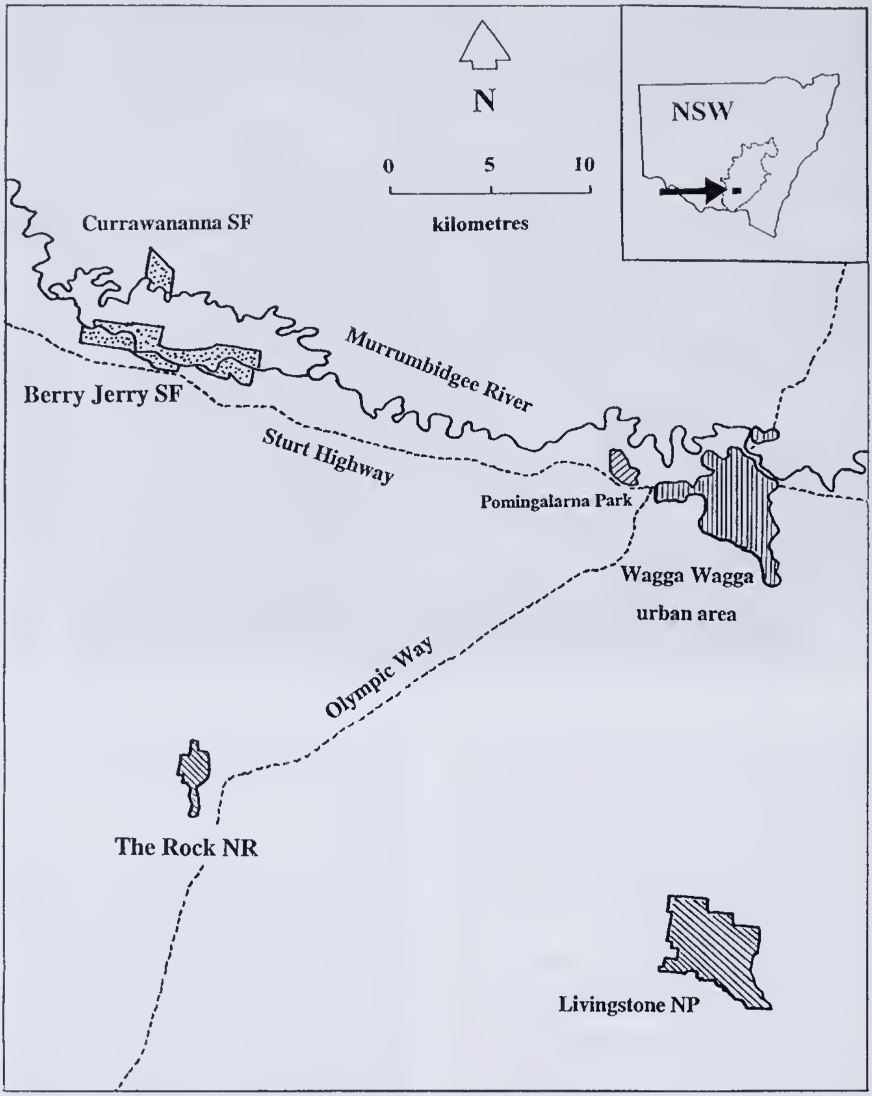

Fig. 1. Location of Berry Jerry State Forest and The Rock Nature Reserve near Wagga Wagga in the NSW South Western Slopes Biogeographic Region. Additional reserves mentioned in the text are also shown.

Approximately 50 ha of grassy open woodland of Grey Box *E. microcarpa*, Yellow Box *E. melliodora* and White Cypress Pine *Callitris glaucophylla* occurs on slightly higher ground in the south of the reserve. Domestic sheep and cattle graze throughout the reserve. Fallen timber remains common despite widespread evidence of timber removal.

The Rock NR (35° 16'S, 147° 04'E), gazetted in 1962 and currently 341 ha in area, is managed by the NSW National Parks and Wildlife Service (NPWS) (now part of the NSW Department of Environment and Conservation). It is located approximately 30 km south-west of Wagga Wagga and comprises a steep

rocky ridge of Devonian quartzite and slate rising about 360 m above the surrounding agricultural countryside. The lower slopes of the Reserve (extending into adjacent freehold properties and a travelling stock reserve) support woodland dominated by Grey Box, White Box *E. albens* and Blakely's Red Gum *E. blakelyi*, with White Cypress Pine, Black Cypress Pine *C. endlicheri* and Red Stringybark *E. macrorhyncha* also present, and a sparse understorey of grasses and shrubs. Higher, steeper slopes in the Reserve support woodland of mainly White Box and Currawang *Acacia doratoxylon* with a heathy understorey, while the ridge top supports Currawang, Dwyer's Mallee Gum *E. dwyeri* and Hill Oak *Allocasuarina verticillata* (Burrows 1999; NPWS 2000). Exposed cliff faces provide nesting and roosting sites for various bird species. Aquatic habitat is limited to a small dam (about 100 m^2 surface area) on the lower slopes of the reserve and additional stock dams on adjoining properties. Domestic stock is excluded from the reserve and the area is managed for conservation.

Survey methods

A field survey of the bird species found in the two study areas was done during four visits to the Wagga Wagga area by the author between January 1999 and July 2003, with one visit occurring in each season. Berry Jerry SF was visited on a total of 14 days and 9 nights during this period, while The Rock NR was visited on 12 days and 3 nights. Diurnal birds were identified by sight or call while walking by day in a random meander through the different vegetation communities present, with 7 x 50 binoculars used to aid observation. Birds with unfamiliar calls were tracked down and identified by sight. Nocturnal birds were identified by sight or call while walking or slowly driving through the study areas at night with a 50 watt spotlight. The species recorded during each field visit were each assigned to one of four categories of abundance, based on the number of individuals or family groups recorded: abundant (more than 50 records), common (15-50 records), uncommon (3-14 records) and rare (1-2 records). The assigned categories were then averaged over the four visits to generate a final category of abundance for each species in each reserve. The results of the field survey were supplemented with records of additional species from the NPWS Atlas of NSW Wildlife and the Birding-Aus internet mailing list archive (http://www.cse.unsw.edu.au/birding-aus) for the period 1995-2003.

The records of Gall (1982), which documented the results of a regional survey of the vertebrate fauna of the South Western Slopes in the late 1970s–early 1980s, were examined and bird records for Berry Jerry SF and The Rock NR retrieved. Gall's survey methods for birds were similar to those employed in the present study, comprising diurnal observation, call recognition and spotlighting, and included 4 days of field survey in Berry Jerry SF and 13 days in The Rock NR between 1977 and 1981 (Gall 1982). Data from Gall's report were supplemented with records of additional bird species from the two study areas for the period 1975-1981 from the NPWS Atlas of NSW Wildlife.

Ecological categories

Species recorded were divided into the following four categories:

1) species dependent on aquatic habitats;
2) species dependent on woodland or forest habitats and considered to be currently declining in the eastern Australian sheep-wheat belt, including species currently listed as threatened under the NSW *Threatened Species Conservation Act 1995* (TSC Act);
3) species of woodland/forest habitats considered to be marginally secure with a risk of decline in the future as a result of dependence on woodland or forest areas; and
4) species of agricultural habitats, comprising both woodland/forest species considered to be relatively tolerant of clearing and fragmentation, together with species from open country habitats.

Assignment of species to the three terrestrial categories was based on review of available references to the status of birds in eastern Australian temperate woodlands; primarily Reid (1999) and Traill and Duncan (2000), but also Loyn (1985), Barrett *et al.* (1994), Robinson (1994), Robinson and Traill (1996), Barrett (1997),

Fig. 2. River Red Gum riverine forest in Berry Jerry State Forest. Uncontrolled grazing by domestic stock is a likely factor in the apparent loss of four declining woodland bird species from this reserve, but strategic grazing is now being used in an effort to replace introduced weeds with native grasses. Photo by Michael Murphy.

Fig. 3. View from the summit of The Rock Nature Reserve, illustrating the context of this small woodland reserve in the modern agricultural landscape of the NSW South Western Slopes. Photo by Michael Murphy.

Bennett and Ford (1997), Egan *et al.* (1997), Murphy (1999) and Reid (2000).

Results

A total of 127 species was recorded in this study (both study areas and both survey periods combined), comprising 123 native species and 4 introduced species. Ninety-three species were recorded in Berry Jerry SF and 108 species in The Rock NR, with 74 species found in both. A complete list of the species recorded is provided in Appendix 1, together with information on when and in which study area each species was recorded and the abundance category for those species recorded in the 1999-2003 field survey.

The 1999-2003 field survey recorded 75 species in Berry Jerry SF, with two species (the Galah and Sulphur-crested Cockatoo *Cacatua galerita*) recorded as abundant, 16 as common, 26 as uncommon and 31 as rare. Table 1 shows the cumulative total of species recorded over the four visits comprising the 1999-2003 field survey. The rate of increase in Berry Jerry SF had slowed by the 4th visit, with only 5% of the species added at that time, suggesting that few additional species remained to be found. Reference to the NPWS Atlas of NSW Wildlife and the Birding-Aus internet mailing list archive indicated no additional species for the study area for the period 1995-2003. Seventy species were recorded in Berry Jerry SF in the period 1975-1981; 62 species by Gall (1982), with records of another eight species from the NPWS Atlas of NSW Wildlife. Fifty-two species were recorded in Berry Jerry SF during both 1975-1981 and 1995-2003, while 18 species were recorded only during 1975-1981 and 23 only in 1995-2003 (Appendix 1).

The 1999-2003 field survey in The Rock NR recorded 80 species. No species were recorded as abundant, 18 were common, 29 were uncommon and 33 were rare. The cumulative total over the four visits of the field survey (Table 1) shows that 10% of the species were first recorded at the 4th visit, suggesting that the species list for The Rock NR was not as close to completion as that of Berry Jerry SF, with additional species probably remaining to be found. Reference to the NPWS Atlas of NSW Wildlife and the Birding-Aus internet mailing list archive identified an additional 12 species for the study area for the period 1995-2003, bringing the total for that period to 92 species. Eighty-nine species were recorded in The Rock NR in the period 1975-1981; 65 species by Gall (1982), with records of another 24 species from the NPWS Atlas of NSW Wildlife. Seventy-three species were recorded in The Rock NR during both 1975-1981 and 1995-2003, while 16 species were recorded only during 1975-1981 and 19 only in 1995-2003 (Appendix 1).

The number of species recorded in each of the four ecological categories is summarised in Table 2. Species of aquatic habitats comprised 16% of the total bird

Table 1. Cumulative total of bird species recorded during 1999-2003 field survey.

	Jan 1999	Apr 2001	Oct 2002	Jul 2003
Berry Jerry SF	40	53	71	75
The Rock NR	29	49	72	80

species recorded in Berry Jerry SF but only 3% in The Rock NR. Species in the 'declining' and 'at risk of decline' categories together made up about two thirds of the terrestrial bird species of both study areas. Berry Jerry SF had 19 species identified as declining woodland species, while 24 declining woodland species were recorded at The Rock NR. Seven threatened bird species (all currently listed as vulnerable under the TSC Act) were recorded during the 1999-2003 field survey, two species in Berry Jerry SF and six species in The Rock NR. One species, the Brown Treecreeper (Fig. 4), was recorded in both study areas, although there is uncertainty whether the form present was the threatened eastern subspecies *Climacteris picumnus victoriae* or the unlisted inland and nominate subspecies *Climacteris picumnus picumnus*, as the Wagga Wagga area lies within the zone of intergradation between the two (Schodde and Mason 1999). Additional information concerning observations of threatened species during the field survey is summarised in Table 3.

Discussion

This study demonstrated that both Berry Jerry SF and The Rock NR are of significant conservation value. Avian values of Berry Jerry SF identified in the present study include extant populations of 15 species of declining woodland birds (including two threatened species) and 25 woodland bird species at risk of future decline, complemented by a range of agricultural birds and waterbirds. The threatened Superb Parrot *Polytelis swainsonii* is likely to breed in Berry Jerry SF, given the proximity of known breeding sites and the abundance of suitable nesting hollows along Beavers Creek (Webster and Ahern 1992; Leslie 2005). Brown Treecreepers remain relatively common and widespread in the reserve. Berry Jerry SF also supports other significant fauna, such as the threatened Squirrel Glider *Petaurus norfolcensis* (Murphy pers. obs. April 2001). None of the waterbirds recorded in Berry Jerry SF is considered of current conservation concern, although the continued restriction of natural flood events as a result of river regulation and extraction of water for agriculture, combined with continuing loss of mature riverine forest in the region, may see this change in the future (Frith 1982; Briggs and Thornton 1999). Current management of Berry Jerry SF aims to assist protection of biodiversity. Forestry prescriptions in the reserve require the retention of all large trees greater than 170 cm diameter at breast height and a proportion of all hollow-bearing trees, including all those within 20 m of Beavers Creek or identified as nesting sites for endangered fauna (Forestry Commission of NSW 1986). Firewood collection is regulated by a permit system. Grazing by domestic stock is managed under a strategic grazing plan (involving increased stocking rates in winter to coincide with annual pasture growth and seeding and destocking over summer to allow native perennials to set seed) in an effort to control introduced species and favour native grasses (Leslie

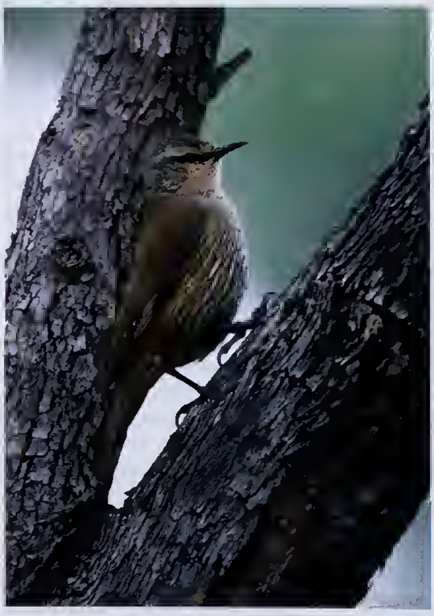

Fig. 4. Brown Treecreeper *Climacteris picumnus*: a threatened woodland bird species. Photo by Marc Irvin.

Table 2. Number of species recorded in four ecological categories (1975-1981 and 1995-2003 survey periods combined).

	Aquatic habitat species	Declining woodland species	Woodland species at risk of decline	Agricultural species	Total
Berry Jerry SF	15	19	32	27	93
The Rock NR	3	24	47	34	108

Table 3. Summary of threatened bird records from 1999-2003 field survey.

Species	Summary of observations
Superb Parrot *Polytelis swainsonii*	Recorded in Berry Jerry SF in October 2002: flock of 8 birds (both sexes) feeding on mistletoes in Box woodland and single male in tree in River Red Gum forest.
Turquoise Parrot *Neophema pulchella*	Recorded in The Rock NR in January 1999 (2 birds in eucalypt tree in woodland on steep upper slopes) and April 2001 (flock of 8 birds feed ing on ground with Red-rumped Parrots in Box woodland on lower slopes).
Brown Treecreeper *Climacteris picumnus*	Common and widespread in River Red Gum forest in Berry Jerry SF, often associated with fallen timber. Recorded every visit. Also recorded every visit in The Rock NR but only seen in relatively flat areas on lower slopes.
Speckled Warbler *Chthonicola sagittata*	Small numbers (2-5) seen on each visit to The Rock NR. Foraging on ground in groups of 2-4 in woodland on lower slopes.
Hooded Robin *Melanodryas cucullata*	Single bird (male) seen in woodland on lower slopes of The Rock NR in April 2001.
Grey-crowned Babbler *Pomatostomus temporalis*	Small groups foraging on ground, fallen timber and lower trunks of Box trees in Box-Cypress Pine woodland on lower slopes of The Rock NR and adjoining freehold property in October 2002 (group of 6 birds) and July 2003 (group of 4 birds).
Diamond Firetail *Stagonopleura guttata*	Single record in woodland on lower slopes of The Rock NR in April 2001.

2000). Berry Jerry SF has been described as the most significant remnant of River Red Gum riverine forest in the Wagga Wagga local government area and one of the most significant in the NSW South Western Slopes region (NPWS 2003). Riverine forests provide the best opportunities for recreating linkages across regional landscapes in the eastern Australian sheep-wheat belt (Reid 1999), and Berry Jerry SF would constitute a significant node in a reconstructed and restored Murrumbidgee regional riverine wildlife corridor.

The woodland bird community of The Rock NR was found to be more diverse than that of Berry Jerry SF, with 23 declining woodland bird species (including six threatened species) and 36 woodland bird species at risk of future decline recorded there since 1995. Additional fauna species of conservation significance known from The Rock NR include the threatened Squirrel Glider and Eastern Long-eared Bat *Nyctophilus timoriensis* (NPWS Atlas of NSW Wildlife) and the regionally significant Inland Carpet Python *Morelia spilota metcalfei* (Murphy and Murphy in press). Conservation of the native flora and fauna is a primary management objective for The Rock NR. Activities such as domestic stock grazing and timber removal are prohibited, weed invasion is monitored and controlled and recreational usage is managed to minimise adverse impacts (NPWS 2000).

Differences between the avian communities of Berry Jerry SF and The Rock NR are in part simply a reflection of differences in the vegetation communities present and habitats available in the two areas. The extensive aquatic habitat present in Berry Jerry SF, for example, supported a wide range of waterbirds including ducks,

cormorants, pelicans, dotterels, herons, ibises and spoonbills, while the small area of aquatic habitat available at The Rock NR supported only low numbers of just a few waterbird species. Similarly, the Yellow Rosella *Platycercus elegans flaveolus*, a sub-species closely associated with River Red Gum riverine forests (Forshaw and Cooper 1981), was commonly seen in Berry Jerry SF but was not seen in The Rock NR, while the Peregrine Falcon *Falco peregrinus* was more frequently recorded at The Rock NR, where it used cliff faces for roosting and nesting, than at Berry Jerry SF, where it was recorded visiting on only a single occasion.

Comparison of the results from 1995-2003 with 1975-1981 provides an opportunity to consider possible temporal changes in the bird communities of the two study areas. However, many of the bird species recorded in this study have mobile habits, including seasonal migrants such as the Rainbow Bee-eater *Merops ornatus* and Olive-backed Oriole *Oriolus sagittatus*, blossom nomads such as the Red Wattlebird *Anthochaera carunculata* and Fuscous Honeyeater *Lichenostomus fuscus*, irregular visitors such as the Masked Woodswallow *Artamus personatus* and White-browed Woodswallow *A. superciliosus*, occasional visitors from more mesic eastern forests such as the Satin Flycatcher *Myiagra cyanoleuca* and Bassian Thrush *Zoothera lunulata* and various raptor species with large home ranges. Confidently demonstrating likely absence of mobile species from a given area is problematic, and it is considered likely that many of the mobile species recorded in 1975-1981 but not 1995-2003 would still occur in the study areas on an irregular basis. To demonstrate this point, although no records of the Little Eagle *Hieraaetus morphnoides* were obtained from Berry Jerry SF during 1995-2003, an individual was seen just 3 km north in Currawananna SF (Fig. 1) (Murphy pers. obs. July 2003). Some of the mobile bird species which are thought to be declining or potentially at risk of decline in the NSW South Western Slopes region, such as the Whistling Kite *Haliastur sphenurus* (The Rock NR) and Brown Goshawk *Accipiter fasciatus* (Berry Jerry SF), may have indeed permanently disappeared from these study areas, but the survey effort in this study was not sufficient to provide certainty in this regard.

The survey effort (including reference to secondary sources) was sufficient to allow more confidence when considering possible temporal changes with respect to sedentary species resident in the study areas. Concentrating on the declining woodland species category, it appears that four species (one fifth of the original declining woodland bird community) may have been lost from Berry Jerry SF at some time over the last two decades: the Speckled Warbler *Chthonicola sagittata*, Eastern Yellow Robin *Eopsaltria australis*, White-browed Babbler *Pomatostomus superciliosus* (Fig. 5) and Diamond Firetail *Stagonopleura guttata*. All four species were targeted during the latter part of the 1999-2003 field survey without success, including searches of sites of earlier records from 1975-1981. These four species were also absent from a list of birds recorded in Berry Jerry SF in 1994-1996 by Bos and Lockwood (1996). Possible reasons for the apparent disappearance of the four species from Berry Jerry SF include grazing impacts, weed invasion, predation by feral cats *Felis cattus* and avian nest predators and extinction debt. All four species are predominantly ground feeding (Barker and Vestjens 1979; Read 1994; Tzaros 1996; Antos and Bennett 2006), and all are likely to be sensitive to changes to the understorey and ground cover. Grazing and trampling of woodlands by domestic stock results in a simplified vegetation understorey structure (Tasker and Bradstock 2006) with an increased proportion of introduced weeds (Benson 1991; Burrows 1999) and decreased diversity of ground-living invertebrates (Bromham *et al.* 1999). Gall (1982) noted the adverse impact of stock grazing in Berry Jerry SF and recommended that stock be permanently withdrawn from the reserve. However, Berry Jerry SF has a high proportion of introduced weeds in the ground layer (Burrows 1999), and Forests NSW has opted for a strategic grazing approach as described above. Grazing management practices in Berry Jerry SF need to be closely monitored and adjusted where necessary to ensure they

Fig. 5. White-browed Babbler *Pomatostomus superciliosus*: a declining woodland bird species. Photo by Michael Murphy.

provide benefit to the reserve's woodland bird community.

Comparing the results from the first (1977-1981) and second (1998-2001) national bird Atlases coordinated by the Royal Australasian Ornithological Union (now Birds Australia), Barrett and Silcocks (2002) concluded that the Diamond Firetail was declining in the NSW South Western Slopes region, while the Speckled Warbler population was stable and the Eastern Yellow Robin and White-browed Babbler were increasing. However, while they do remain locally common in some parts of the region, all four species have been found to be locally declining in other parts of the region (Reid 1999). The woodland birds going locally extinct can vary from one location to the next (Reid 2000), and such local-scale patterns may be difficult to discern at a regional spatial scale.

In contrast to Berry Jerry SF, with the possible exception of one species (the Whistling Kite as noted above), the community of declining woodland birds in The Rock NR was found to remain intact between 1975-1981 and 1995-2003, including all four species missing from Berry Jerry SF. Nevertheless, because of the reserve's small size, there remains a significant risk that some sedentary woodland bird species may disappear from there in the future, particularly if isolation of the reserve increases. Four of the six threatened bird species recorded in The Rock NR during the 1999-2003 field survey were classified as rare, suggesting that resident populations of these species were only small. The Hooded Robin *Melanodryas cucullata* is of particular concern, recorded only on a single occasion during the 1999-2003 field survey. The Hooded Robin is apparently unable to maintain viable populations in isolated areas of habitat smaller than 100-200 ha (Egan *et al.* 1997; Fitri and Ford 1997; Traill and

Rufous Songlark *Cincloramphus mathewsi*: a woodland bird species at risk of future decline. Photo by Michael Murphy.

Duncan 2000). Given that the total area of The Rock NR is only 341 ha, with about half of this comprising steep slopes and ridgetops, the area of suitable habitat available within the reserve may not be sufficient to maintain a viable population of this species. Fortunately, despite extensive clearing in the local area, The Rock NR is not completely isolated, and the area of woodland habitat available within the reserve is currently complemented by additional areas on adjoining freehold properties and a travelling stock reserve, and by (sometimes tenuous) linkages to other small remnants in the local area. Actively supporting and encouraging the protection, management and restoration of these additional habitat areas and local linkages is probably critical to the viability of the Hooded Robin and many other woodland bird populations within the reserve. Restoring habitat connectivity between The Rock NR and nearby larger remnants such as Berry Jerry SF (21 km north) and Livingstone National Park (24 km south-east) (Fig. 1) would be a worthwhile longer-term goal, although likely to prove challenging.

A study of the bird community of another local woodland remnant, Pomingalarna Park (Fig. 1), provided results with similarities to the present study. A field survey in this 225 ha woodland remnant in 1992-1997 (Murphy 1999) recorded 25 declining woodland bird species (including six threatened species). Declining woodland birds observed at Pomingalarna Park, but not recorded at either Berry Jerry SF or The Rock NR, included the Brown Quail *Coturnix ypsilophora*, Crimson Chat *Ephthianura tricolor*, Gilbert's Whistler *Pachycephala inornata* (vulnerable under TSC Act) and White-backed Swallow *Cheramoeca leucosternus* (Murphy 1999). The present study, together with the Pomingalarna study, provides useful reference information for future assessment of changes in the status of species in the Wagga Wagga area. Comparison with the earlier work by Gall (1982) illustrates how such studies can be used to examine possible changes in bird communities over time. Site-based studies of this type are a useful approach to understanding the local details of large-scale patterns such as the regional decline of woodland birds. A re-examina-

tion of the bird communities of Berry Jerry SF and The Rock NR (and Pomingalarna Park) in 2020 would be worthwhile.

Conclusion

The present study found that species in the 'declining' and 'at risk' categories made up about two thirds of the terrestrial bird communities of both Berry Jerry SF and The Rock NR. The loss of this many species from these areas would be devastating. Recher (1999) warned that losses of this intensity were likely at a continental scale, predicting that half of Australia's terrestrial bird species could be extinct by 2100 as a result of continuing ecologically unsustainable human activities. Major coordinated and strategic landscape recovery works are required if Recher's dire future is to be avoided. The NSW South Western Slopes region has already been over-cleared (State of the Environment Advisory Council 1996; Pressey *et al.* 2000), to the extent that even single trees remaining in paddocks are considered of notable ecological significance (Gibbons and Boak 2002). History shows that we are still paying the extinction debt from past land clearing practices. The clearing undertaken, as you read this paper, will be paid for with local species extinctions in 50 years' time. A 'no net loss' approach to the management of native vegetation is not sufficient and will see the current *status quo* of gradual decline continue. A 'net gain' approach to vegetation management is essential to reverse the decline. Surviving remnants of native vegetation need to be protected, and remnants particularly significant because of their size, strategic location or unique value need to be identified and their management improved. Strategic regeneration and restoration is needed to expand the size of existing remnants and to restore connectivity across the landscape. Research into the status of woodland birds and other biodiversity components at a regional and local scale needs to be supported, including monitoring of the effectiveness of restoration efforts so that they can be refined as necessary. The above work must be done in partnership with landholders and local community groups if it is to succeed. Various biodiversity conservation and landscape restoration projects and initiatives are already underway in many districts, but much work remains to be done. The agricultural productivity of the NSW South Western Slopes region is an economic resource of national significance and the restoration of the region to ecological sustainability warrants substantial national attention and support.

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Appendix.
Bird species recorded from Berry Jerry SF and The Rock NR. Status in 1999-2003 field survey by author: A = abundant; C = common; U = uncommon; R = rare. 3= record from Gall (1982); @ = record from Atlas of NSW Wildlife. # = record from the Birding-Aus internet mailing list archive. (T) = species currently listed as threatened under NSW *Threatened Species Conservation Act* 1995. * = introduced species. Species names follow Christidis and Boles (1994).

Species		Berry Jerry SF		The Rock NR	
		1975-1981	1995-2003	1975-1981	1995-2003
Category 1: species of aquatic habitats					
Australian Shelduck	*Tadorna tadornoides*		R		
Australian Wood Duck	*Chenonetta jubata*	3	C	3	R
Pacific Black Duck	*Anas superciliosa*	3	C		
Grey Teal	*Anas gracilis*	3	U		
Domestic Goose	*Anser anser* *		U		
Little Pied Cormorant	*Phalacrocorax melanoleucos*		U		
Little Black Cormorant	*Phalacrocorax sulcirostris*		R		
Great Cormorant	*Phalacrocorax carbo*	3	R		
Australian Pelican	*Pelecanus conspicillatus*		U		
White-faced Heron	*Egretta novaehollandiae*	3	U		R
Australian White Ibis	*Threskiornis molucca*	3			
Straw-necked Ibis	*Threskiornis spinicollis*		U		
Yellow-billed Spoonbill	*Platalea flavipes*		R		
White-bellied Sea-Eagle	*Haliaeetus leucogaster*	3			
Masked Lapwing	*Vanellus miles*			3	R
Black-fronted Dotterel	*Elseyornis melanops*	3			
Category 2: declining woodland species					
Whistling Kite	*Haliastur sphenurus*	3	R	3	
Painted Button-quail	*Turnix varia*	3	R	@	U
Peaceful Dove	*Geopelia striata*	3	C	3	C
Little Lorikeet	*Glossopsitta pusilla*		R		
Superb Parrot	*Polytelis swainsonii* (T)	3	R		
Turquoise Parrot	*Neophema pulchella* (T)			@	R
Brown Treecreeper	*Climacteris picumnus* (T)	3	C	3	U
Speckled Warbler	*Chthonicola sagittata* (T)	@		3	U
Chestnut-rumped Thornbill	*Acanthiza uropygialis*			@	R
Southern Whiteface	*Aphelocephala leucopsis*				R
Jacky Winter	*Microeca fascinans*		R	3	U
Red-capped Robin	*Petroica goodenovii*		R	3	C
Hooded Robin	*Melanodryas cucullata* (T)			3	R
Eastern Yellow Robin	*Eopsaltria australis*	@		3	C
Grey-crowned Babbler	*Pomatostomus temporalis* (T)				R
White-browed Babbler	*Pomatostomus superciliosus*	3		3	C
Varied Sittella	*Daphoenositta chrysoptera*	@	R	3	C
Crested Shrike-tit	*Falcunculus frontatus*	3	R	3	R
Rufous Whistler	*Pachycephala rufiventris*	3	U	3	U
Restless Flycatcher	*Myiagra inquieta*	3	U	3	U
Masked Woodswallow	*Artamus personatus*		U		U
White-browed Woodswallow	*Artamus superciliosus*		U		U
Dusky Woodswallow	*Artamus cyanopterus*	3	U	3	C
Apostlebird	*Struthidea cinerea*				U
Double-barred Finch	*Taeniopygia bichenovii*				#
Diamond Firetail	*Stagonopleura guttata* (T)	3		3	R
Category 3: woodland/forest species at risk of decline					
Brown Goshawk	*Accipiter fasciatus*	3		@	@
Little Eagle	*Hieraaetus morphnoides*	3		3	@
Australian Hobby	*Falco longipennis*		R	3	R
Peregrine Falcon	*Falco peregrinus*		R	@	U
Common Bronzewing	*Phaps chalcoptera*	@		3	U

Appendix 1 cont'd.

Crimson Rosella	*Platycercus elegans elegans*			3	
Yellow Rosella	*Platycercus elegans flaveolus*	3	C		
Fan-tailed Cuckoo	*Cacomantis flabelliformis*			3	@
Horsfield's Bronze-Cuckoo	*Chrysococcyx basalis*			@	R
Shining Bronze-Cuckoo	*Chrysococcyx lucidis*			3	
Southern Boobook	*Ninox novaeseelandiae*		U	@	U
Tawny Frogmouth	*Podargus strigoides*	3	U	@	
Australian Owlet-nightjar	*Aegotheles cristatus*			3	R
Sacred Kingfisher	*Todiramphus sanctus*	3	U	@	U
Dollarbird	*Eurystomus orientalis*	3	R		
White-throated Treecreeper	*Cormobates leucophaeus*			3	C
Spotted Pardalote	*Pardalotus punctatus*	@	U	3	U
Striated Pardalote	*Pardalotus striatus*	3	U	3	R
Weebill	*Smicrornis brevirostris*	@	R	3	@
Western Gerygone	*Gerygone fusca*		U	@	R
White-throated Gerygone	*Gerygone olivacea*				R
Inland Thornbill	*Acanthiza apicalis*			3	@
Striated Thornbill	*Acanthiza lineata*			3	
Brown Thornbill	*Acanthiza pusilla*			3	U
Buff-rumped Thornbill	*Acanthiza reguloides*			3	U
Yellow Thornbill	*Acanthiza nana*			3	C
Red Wattlebird	*Anthochaera carunculata*	3		@	
Spiny-cheeked Honeyeater	*Acanthagenys rufogularis*	3		@	
Little Friarbird	*Philemon citreogularis*	3	U	@	
Yellow-faced Honeyeater	*Lichenostomus chrysops*				R
Grey-fronted Honeyeater	*Lichenostomus plumulus*	3			
Fuscous Honeyeater	*Lichenostomus fuscus*	3		@	U
Brown-headed Honeyeater	*Melithreptus brevirostris*		R	3	R
Scarlet Robin	*Petroica multicolor*	@	R	3	R
Flame Robin	*Petroica phoenicea*	3	R	3	R
Golden Whistler	*Pachycephala pectoralis*	@	R	3	R
Grey Shrike-thrush	*Colluricincla harmonica*	3	C	3	C
Leaden Flycatcher	*Myiagra rubecula*				@
Satin Flycatcher	*Myiagra cyanoleuca*			@	
Grey Fantail	*Rhipidura fuliginosa*	3	U	3	C
White-winged Triller	*Lalage sueurii*		R		@
Olive-backed Oriole	*Oriolus sagittatus*		R	@	
Grey Butcherbird	*Cracticus torquatus*		R	3	
White-winged Chough	*Corcorax melanorhamphos*	3	C	3	C
Red-browed Finch	*Neochmia temporalis*			3	R
Mistletoebird	*Dicaeum hirundinaceum*		R	@	R
Tree Martin	*Hirundo nigricans*	3	U		R
Rufous Songlark	*Cincloramphus mathewsi*	3	R	@	R
Silvereye	*Zosterops lateralis*			3	R
Bassian Thrush	*Zoothera lunulata*			3	
Category 4: agricultural species					
Black-shouldered Kite	*Elanus axillaris*		R	@	
Wedge-tailed Eagle	*Aquila audax*	3	R	3	R
Brown Falcon	*Falco berigora*				R
Nankeen Kestrel	*Falco cenchroides*	3	R	@	R
Rock Dove	*Columba livia* *			3	
Crested Pigeon	*Ocyphaps lophotes*	3	U	3	C
Galah	*Cacatua roseicapilla*	3	A	3	C
Little Corella	*Cacatua sanguinea*				U
Sulphur-crested Cockatoo	*Cacatua galerita*	3	A		U
Cockatiel	*Nymphicus hollandicus*	3			
Eastern Rosella	*Platycercus eximius*	3	C	3	C
Red-rumped Parrot	*Psephotus haematonotus*	3	C	3	U
Barn Owl	*Tyto alba*	3			
Laughing Kookaburra	*Dacelo noveaguineae*	3	C	3	U
Rainbow Bee-eater	*Merops ornatus*	3		3	U
Superb Fairy-wren	*Malurus cyaneus*		U	3	U
Yellow-rumped Thornbill	*Acanthiza chrysorrhoa*	3	R	3	U

Appendix 1 cont'd.

Noisy Miner	*Manorina melanocephala*	3	U	3	U
White-plumed Honeyeater	*Lichenostomus penicillatus*	3	C	3	C
Magpie-lark	*Grallina cyanoleuca*	3	C	3	U
Willie Wagtail	*Rhipidura leucophrys*	3	C	3	C
Black-faced Cuckoo-shrike	*Coracina novaehollandiae*	3	U	@	U
White-breasted Woodswallow	*Artamus leucorynchus*	3	R		R
Black-faced Woodswallow	*Artamus cinereus*				@
Pied Butcherbird	*Cracticus nigrogularis*			@	@
Australian Magpie	*Gymnorhina tibicen*	3	C	3	C
Pied Currawong	*Strepera graculina*	3	R	3	U
Australian Raven	*Corvus coronoides*	3	C	3	U
Little Raven	*Corvus mellori*	3	U	3	C
Riehard's Pipit	*Anthus novaeseelandiae*				@
Zebra Fineh	*Taeniopygia guttata*			3	
European Goldfinch	*Carduelis carduelis* *			3	
Weleome Swallow	*Hirundo neoxena*	3	C	@	R
Fairy Martin	*Hirundo ariel*	3	U		R
Brown Songlark	*Cincloramphus cruralis*			@	@
Common Starling	*Sturnus vulgaris* *	3		3	R
Total speeies (separate survey periods)		**70**	**75**	**89**	**92**
Total speeies (surveys eombined)		**93**		**108**	

One Hundred Years Ago

THE NEGATIVE PHOTOTAXIS OF BLOW-FLY LARVAE.

by Prof. A.J. Ewart, Ph.D., D.SC., F.L.S., &c.

On moving a heap of manure recently many thousands of active maggots were left behind, and it was noticed that these immediately began to crawl rapidly towards some loose earth lying at the foot of a tree, in which they buried themselves, traversing a distance of 5 to 12 feet before doing so. The phenomenon was a remarkable one, since hundreds of the larvae could be seen crawling rapidly in an almost straight course for the base of the tree, without a single one progressing in the opposite direction or diverging to any extent laterally. That the movement was not directed by ordinary vision or by smell is shown by the fact that a piece of manure placed within an inch of the maggots on the outward side did not attract them, and that they passed such heaps unnoticed unless they were actually in their path. In the latter case the larvae at once buried themselves in the heap. The path of movement towards the tree was slightly down hill, but on changing the position of the grubs they crawled up hill towards the same destination, and also crossed a ridge of hard soil placed across their downward path. Evidently, therefore, the response is not a geotropic one.

From *The Victorian Naturalist* **XXIV** p. 61, December 1907.

Decline in numbers of Little Penguin *Eudyptula minor* at Middle Island, Warrnambool, Victoria

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Abstract
Throughout the six years till 2005 Little Penguins *Eudyptula minor* at Middle Island, Warrnambool, have been subjected to intense fox predation. The population of the Little Penguin at Middle Island is now dangerously low, with a reduction from 342 active burrows in 1999 to the current 52 active burrows, and from 502 to 4 Little Penguins arriving at the colony after dusk. Such a reduction in numbers requires urgent management measures in order for the colony to survive. (*The Victorian Naturalist* **124** (1), 2007, 19-22)

Introduction

The Little Penguin *Eudyptula minor* is the smallest of all the penguin species and holds an important position in the functioning of the marine ecosystems across its range (Gales 1989). Endemic to southern Australia and New Zealand (Marchant and Higgins 1990), the Little Penguin enjoys high community appeal and tourism status. The famous 'Penguin Parade' at Phillip Island (Victoria, Australia), with its nightly arrival of Little Penguins, attracts nearly 500 000 visitors annually (Anon. 2005).

Drawn to land for breeding and moulting purposes, Little Penguin pairs typically nest in burrows amongst vegetated sand dunes, tussocks or rock crevices located close to the sea. The Little Penguin is unique as it can breed in isolated pairs or as part of a colony. Consequently, Little Penguin colonies vary in size and situation (Simpson 1972). The Bass Strait area, with about 60% of the known breeding population, is the stronghold for the species in Australia (Dann *et al.* 1996).

Although the Little Penguin is classified as lower risk on the IUCN Red List (Ellis *et al.* 1998), a recent decline in numbers has been documented (Dann 1992). European settlement has greatly modified Little Penguin habitat via agriculture, housing, recreational activities and erosion (Harris and Bode 1981). Other threats include oil pollution, discarded plastic products, and fire. Feral animals are a considerable threat, and in some areas penguins are still deliberately killed for bait. Today in Australia, Little Penguin colonies are restricted to areas where human disturbance and predation by introduced species are limited, such as offshore islands (Fortescue 1995; Rogers *et al.* 1995; Wienecke *et al.* 1995). The relatively few colonies on the Australian mainland are generally situated at the base of cliffs and areas inaccessible to mammalian carnivores (Dann 1992). Figure 1 shows sites of larger colonies in south-eastern Australia.

Declines in population sizes of Little Penguin colonies have been reported in Sydney (NSW National Parks and Wildlife Service 2000; Department of Environment and Conservation 2006); and in western Victoria at Port Fairy (Marchant and Higgins 1990) and Portland Harbour (Dann *et al.* 1996). Declines have been caused by habitat loss, predation by canids and oil spills. We have previously reported that in 2000, 342 active Little Penguin burrows existed on Middle Island, Warrnambool, but that unregulated human visitation and canid predation were contributing to a population decline (Overeem and Wallis 2003). We documented a loss of 33% of chicks and 16% of eggs during the 1999/2000 breeding season when visitors to the island trampled their burrows. Most recently there have been several occurrences of fox predation at Middle Island, with the most devastating resulting in 268 Little Penguin carcasses being found at the colony.

The aim of this study is to determine the effects that fox predation and human disturbance have had on Middle Island, through assessing population change. We

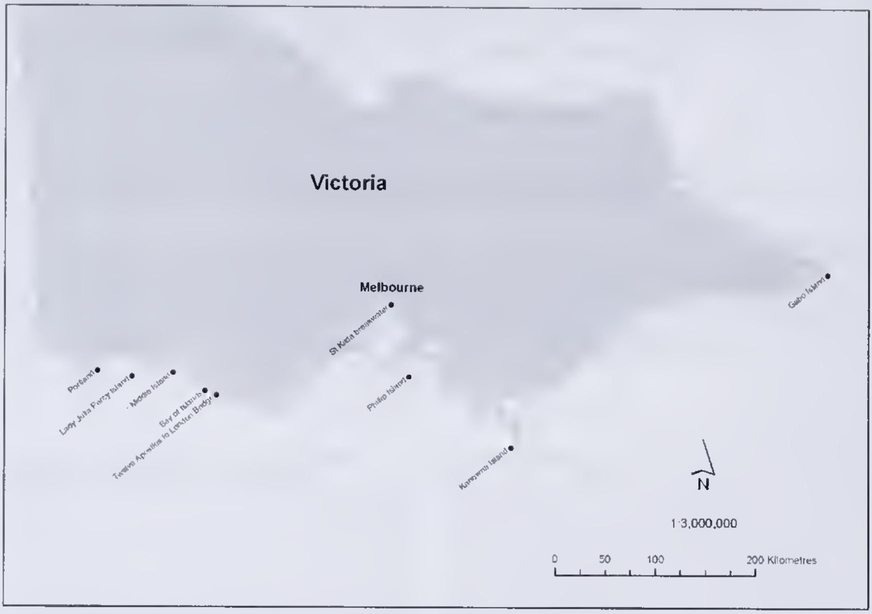

Fig. 1. Location of Middle Island in relation to other known colonies of Little Penguins in south-eastern Australia.

therefore compare our results to the censuses made at Middle Island in 1999/2000.

Materials and methods

Study site

Middle Island, Warrnambool (38°20'S 142°30'E) is located along Victoria's south-west coastline, approximately 263 km from Melbourne (Anon. 1999/2000). Locally known as Penguin Island, Middle Island is a 1.5 hectare island situated at the western approach to Lady Bay, at the mouth of the Merri River.

Access to Middle Island is through Stingray Bay, which in the past was deep enough to prevent humans crossing without a boat. The building of a breakwater caused 26 hectares of beaches and subsequent sandbars to form. Today, Middle Island is easily accessed through tide heights of less than 0.1 m, although the adventurous may access the island at any tide.

The Warrnambool City Council (WCC) currently manages Middle Island using advice from Deakin University, the Department of Sustainability and Environment (DSE) and Parks Victoria. In 2002 a boardwalk system was constructed in an effort to protect the Little Penguin colony. Forty artificial burrows were also introduced to the site. While tide and wave height aid in restricting access, penguin viewing is unregulated.

The Phillip Island Penguin Study Group have flipper-banded Little Penguins at Middle Island since the 1970s, and in October 1993, 336 were banded (Thoday unpublished data). The first ecological study was undertaken by Overeem and Wallis (2003). Notable differences in breeding success, breeding calendar and morphometrics have been recorded between the Middle Island Little Penguin colony and other colonies in the Bass Strait region (Cullen *et al.* 1992; Overeem and Wallis 2003).

Fox predation is not new to Middle Island (see Overeem and Wallis 2003). However, of concern is the current frequency of attacks and number of penguins killed in each. We estimate that just under 500 Little Penguins have been killed by foxes at Middle Island over the past six years, based on counts of carcasses. The Little Penguins utilise six entrances to access the upper surface of Middle Island. The peak dusk arrival was recorded by

Overeem and Wallis (2003) in January 2000 as 502 Little Penguins arriving. Since then many penguin carcasses have been collected from each landing site.

Active burrow abundance map

Fieldwork was undertaken in mid-September as past research suggested the Little Penguins at Middle Island would be nesting, incubating eggs or guarding young chicks (Overeem and Wallis 2003; R. Jessop pers. comm.). This period is thought to result in the most accurate count of breeding pairs (BIOMASS Working Party on Bird Ecology 1982). The nearby colonies at Lady Julia Percy Island and London Bridge were also checked for activity to confirm breeding status in western Victoria. The active burrow mapping was completed as described in Overeem and Wallis (2003) in an effort to efficiently compare data.

Little Penguin night arrival

The Little Penguin night arrival count was undertaken as described in Overeem and Wallis (2003). On the 21 September 2005 the penguins arriving at all six landing sites were counted by experienced penguin personnel. The count lasted one hour and began when the first penguin accessed the island.

Results and discussion

Active burrow count

The vegetated upper surface of Middle Island had 52 active burrows, at a density of 0.003/ m^2 (Fig. 1). Interestingly, no live birds were seen or heard during the count and therefore all burrows were identified through the presence of tracks or scats. It is therefore possible that the burrows counted may have resulted in an over-estimation of the number of active Little Penguin burrows at Middle Island.

Little Penguin Night Arrival

A total of four Little Penguins were counted accessing Middle Island in a one hour period. One penguin was counted on the 'main landing site' Entrance 3. Two birds were counted arriving at Entrance 4, while another single bird was counted at Entrance 5. No penguins were counted arriving at Entrances 1, 2 and 6 (Fig. 2).

Fig. 2. Active burrow map for the Little Penguin at Middle Island September 2005. Each number rcpresents the total number of active burrows found in the quadrat, ^ represents an active artificial burrow within the quadrat, E represent entrance names.·

Decline in population

In January 2000 we recorded 502 penguins arriving on Middle Island and there were 342 active burrows. Clearly there had been a significant decline in penguin numbers by September 2005 when only four birds were observed at their nightly arrival and 52 active burrows present.

Management options

Fox control strategies including regular fox trapping, baiting, shooting and destroying of dens are needed (Anon. 2005). After some frustrating delays, these strategies are being undertaken on the mainland near Middle Island, but it is critical that this level of effort is maintained over a wider area.

There is a need to control visitor access. Our previous study (Overeem and Wallis 2003) highlighted the number of eggs and chicks that humans have trampled, and while erection of boardwalks and the installation of nest boxes would reduce this

impact, the numbers of people and their dogs need to be controlled.

Future changes in numbers of penguins at Middle Island will need to be closely monitored. Since we believe there is migration between colonies (Overeem unpublished data on genetics of colonies, Australian Bird and Bat Banding Scheme unpublished data), there is a possibility of re-colonisation occurring at Middle Island. However, previously existing local colonies which are now extinct (Portland and Griffith Island) suggest that this will not happen readily.

The status of the Little Penguin colony at Middle Island should be reviewed. The declaration of the Manly Point colony as endangered under NSW legislation has merit and a similar scheme for Victoria could highlight species that are facing extirpation.

Acknowledgements

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An exercise in lichenometry at Point Lonsdale

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Abstract

The growth of a white crustose lichen growing on concrete gravestones at the Point Lonsdale Cemetery was investigated. It was found that the growth rate of the lichen could be determined by using the date on the headstone, and that larger lichens tended to have a greater rate of growth. Orientation of the longest lichen axis was non-random and appears to be related to the direction of rain-bearing winds. (*The Victorian Naturalist* **124** (1), 2007, 23-26)

Introduction

Lichenometry deals with the measurement of lichen parameters, such as size, shape, rate of growth and density of thalli. These parameters may vary with age and with position of the substratum in terms of its exposure to variables such as wind, shade and atmospheric pollutants. Lichens are one of the first colonisers of rocks and are important in the management of stone monuments and buildings, as some lichens make their substratum more porous by generating oxalic and other acids and aid the weathering process (Lisci, Monte and Pacini 2001).

pH of the substratum can affect species composition, e.g. calcicolous lichens grow on neutral or alkaline substrata while silicicolous lichens grow on acidic substrata. Others can grow on any substratum. This paper deals with a white crustose lichen (Fig. 1) that commonly grows on concrete, an alkaline substratum. The aim of this study was to examine the growth of this species on concrete slabs in the Point Lonsdale Cemetery, specifically to determine whether there was a relationship between length of the longest axes of lichens and age on the headstone, whether the longest axes occurred along a particular orientation and whether growth rate varied with thallus size.

Methods

The maximum length and width of the largest lichen growing on the horizontal slabs of each of 16 graves at the Point

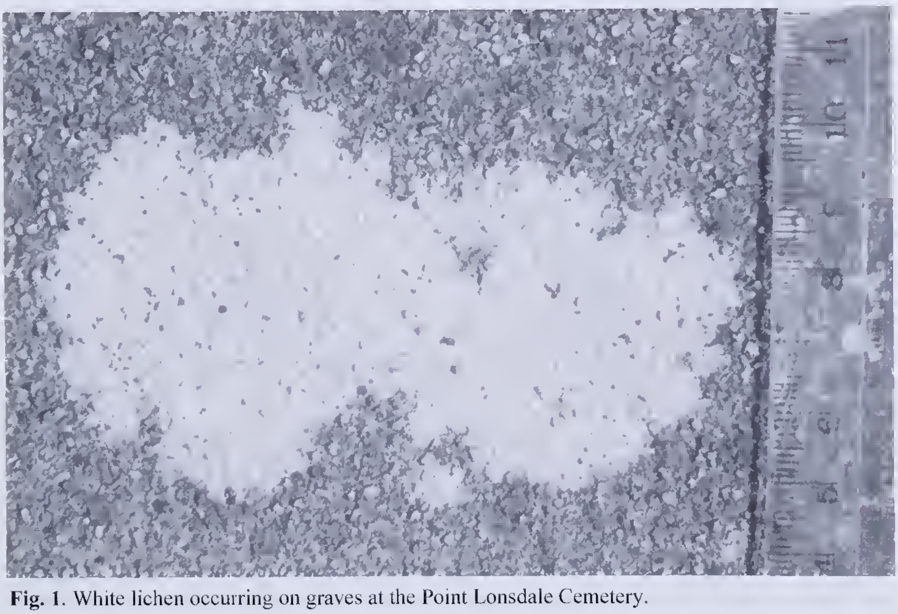

Fig. 1. White lichen occurring on graves at the Point Lonsdale Cemetery.

Lonsdale Cemetery was measured and compared with the age on the headstone. Point Lonsdale is on the western head of Port Phillip Bay, 130 km via Geelong from Melbourne.

Thalli were measured to the nearest 0.1 mm using digital vernier ealipers. As well, the orientation of the longest axis was measured for the lichens with a Silva prismatic eompass to determine whether this was along the direetion of the prevailing weather. The eoncrete slabs were of uniform length and width, 2 m by 0.88 m respectively, and of similar conerete composition.

Similarly, the maximum length and width of fifty-one thalli on a single slab was measured on 1 June 2000 and re-measured on 27 July 2003, about 38 months later. The exaet position of the liehens on the slab was determined to ensure that the growth rate of eaeh lichen could be calculated. Again, the orientation of the longest axis of eaeh liehen was measured.

Results

Ages on the 16 headstones ranged from 27.7 years to 54.9 years (Table 1). The length of the longest axes varied from 30 mm to 63 mm. There was a strong correlation (r = 0.92; P = 0.001) between age on the headstone and maximum lichen length. Regression analyis allowed determination of the theoretieal age of the headstones (Table 1). A Chi Square goodness of fit (χ^2=4.5, df = 15, P = 0.995) showed there was no differenee between aetual age and theoretical age. This supported the strong eorrelation determined for lichen length and age on the headstone. Almost half the observed ages on the headstones were less than the theoretieal ages predieted (Table 1), presumably due to a time lag between the burial and ereetion of the headstone.

Liehen growth rates were determined from the division of the maximum liehen length by the age on the headstone. Growth rates ranged from 0.9 to 1.3 mm p.a. (Table 1) but showed only a weak positive eorrelation with age on the headstone, whieh was not significant (r = 0.4, P = 0.1). Length and width correlated strongly with eaeh other (r = 0.97, P = 0.001), but the length:width ratio (Table 1) showed only a weak eorrelation with age on the headstone (r = -0.45, P = 0.1).

Growth rates of the fifty-one liehen thalli on the single slab also were determined and ranged from 0 to 2.3 mm p.a. with an average of 0.88 mm p.a. (Table 2), marginally lower than the 1.1 mm p.a. average using the multi-slab technique. This was expected as the single slab sampling used all liehen thalli while the multi-slab sampling used only the largest thallus. Comparison of growth rate with initial maximum liehen length showed that growth rate inereased with increasing

Table 1. Lichenometric data from sixteen gravestones.

age on headstone (years)	maximum length (mm)	width (mm)	orientation of longest axis (degrees from North)	growth rate (mm/year)	length/ width ratio	theoretieal age (years)
27.7	31.0	25.0	105	1.1	1.2	30.7
34.1	32.7	27.9	150	1.0	1.2	32.0
34.2	30.0	23.5	135	0.9	1.3	32.0
34.2	32.7	29.9	150	1.0	1.1	29.9
40.8	50.0	48.5	47	1.2	1.0	45.1
43 0	40.5	32.0	150	0.9	1.3	37.9
45.7	61.0	58.0	68	1.3	1.1	53.4
46.3	56.4	58.6	7	1.2	1.0	49.9
47.5	52.0	47.6	30	1.1	1.1	46.6
48.4	53.5	52.0	21	1.1	1.0	47.7
50.3	60.7	52.0	45	1.2	1.2	53.2
51 0	61.0	50.0	75	1.2	1.2	53.4
52.1	57.7	53.5	135	1.1	1.1	50.9
53.7	55.4	54.5	0	1.0	1.0	49.2
54.3	63.0	57.0	20	1.2	1.1	54.9
54.9	59.5	54.7	150	1.1	1.1	52.3

lichen size (r = 0.44, P = 0.002). Thalli above an initial maximum length of 50 mm had the fastest rate of growth. The length:width ratio averaged 1.17, comparable to that obtained using the multi-slab technique, i.e. 1.10. The length/width ratio had only a weak correlation with maximum lichen length (r = 0.42, P = 0.005).

Lichen thalli from both slabs were used to determine whether the long axes occurred along a particular orientation. Data was divided into twelve orientation classes of 15° spans. The primary mode was along the 150° axis while two secondary modes occurred along the 135° and 75° axes (Fig. 2). The distribution was significant (χ^2 = 22.8, df = 11, P = 0.025), i.e. a factor or factors other than chance was responsible for determining orientation of the longest axes.

Table 2. Lichenometric data obtained using multiple gravestones.

maximum length (mm)	growth rate (mm/year)	L/W ratio	orientation (degrees from North)
11.0	0.3	1.2	110
11.0	0.1	1.1	24
13.0	1.0	1.4	158
14.0	0.2	1.5	74
16.0	1.4	1.3	116
17.5	1.1	1.2	18
19.0	1.0	1.2	30
20.0	1.0	1.3	148
20.0	0.8	1.1	86
20.0	1.8	1.2	42
20.0	0.2	1.3	142
21.0	0.2	1.1	150
21.0	0.9	1.3	163
22.0	0.1	1.1	150
22.0	0.3	1.3	110
23.0	1.6	1.2	125
24.0	0.6	1.1	172
26.0	0.2	1.1	40
28.0	0.3	1.1	116
28.0	0.7	1.1	82
28.0	0.7	1.1	82
29.0	0.2	1.4	80
29.0	0.8	1.3	110
30.0	0.1	1.1	172
30.0	0.1	1.1	120
31.0	1.1	1.4	0
31.0	2.1	1.3	72
31.0	0.3	1.1	117
31.0	0.0	1.1	52
33.0	0.2	1.1	10
35.0	1.4	1.1	90
36.0	0.4	1.2	40
36.0	0.0	1.1	105
37.0	1.3	1.1	155
37.0	1.0	1.1	36
38.0	1.6	1.2	50
38.0	1.6	1.1	60
39.0	0.5	1.0	70
39.0	0.9	1.3	143
40.0	1.6	1.2	145
40.0	1.7	1.0	154
42.0	1.3	1.3	105
44.0	0.4	1.1	140
45.0	0.1	1.1	140
45.0	1.6	1.0	128
46.0	0.9	1.1	155
48.0	2.2	1.2	130
50.0	0.8	1.1	122
51.0	2.0	1.1	146
52.0	2.5	1.1	140
52.0	2.3	1.0	170

Discussion

Bull and Brandon (1998) used the lichen genus *Rhizocarpon* to date earthquake generated rock fall events in the Southern alps of New Zealand. Their work was based on the single largest lichen or the mean of five of the largest lichens for each deposit. They listed a variety of recommendations concerning site selection and factors affecting lichen growth.

Innes (1984, 1986a) and Spence and Mahaney (1988) argue that the ideal sampling strategy in lichenometry should try to minimize inherent measurement variability by considering sample area and the density of lichen thalli. The ideal data set would come from the largest measured isolated lichen in a number of fixed-size sample areas with identical growth and conditions for colonization.

In this study the slabs on the graves were of uniform length and width and of similar composition. Density of lichens varied somewhat, but several graves had 50 or more thalli. The sampling strategy, thus, essentially met the conditions of Innes, Spence and Mahoney and that of Bull and Brandon.

Growth rate increased as lichen size increased. Bull and Brandon (1998) found similar results for *Rhizocarpon* in New Zealand, using a much greater sample size. Thus age is a factor in determining lichen size, hence the strong correlation between age on the headstone and maximum lichen length. When all sizes of lichen are considered from the one slab, the correlation between growth rate and age on the headstone is likely to be weak, and perhaps not significant.

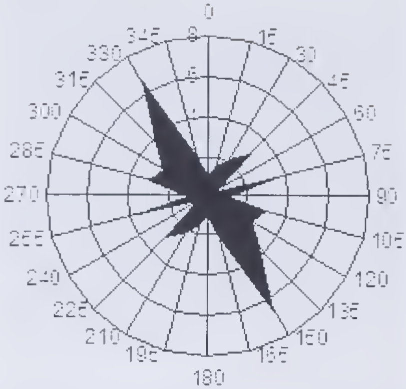

Fig. 2. Pattern showing orientation of long axes of lichens on gravestones at Point Lonsdale Cemetery. Rings represent the number of lichens. Numbers shown around the outside of the diagram show orientation in terms of degrees from North (0°).

Trunk lean, wind ramps in the tree canopy, elongated tree bole profiles, direction of fallen limbs and canopy profiles have been used to determine the dominant prevailing wind in an area Schleiger (1982, 1983, 1991, 2004). For Victoria the most frequent prevailing wind throughout the year is NW and NNW with westerlies and southwesterlies especially in the winter. The cool change or cold front is preceded by the northerlies (NNW and NW) with a wind swing through westerlies and southwesterlies when the cool change passes through from W to E across the state. Rain usually falls with the northerly component, followed by showers from the W and SW in the clearing phase. The pattern of the rosette in Figure 2 reflects that of the tree rosettes at Bundoora, Coburg and Carlisle Forest in the Otways. The similarity of directional pattern with the lichen growth on the slabs suggests the idea of directional rain as an influence in the direction of growth of the lichen thallus investigated in this study.

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Heidelberg mistletoes revisited: decadal changes in the distribution of Creeping Mistletoe *Muellerina eucalyptoides* on introduced trees in suburban Melbourne

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Abstract
Introduced tree hosts of creeping mistletoe in Heidelberg, Victoria, were resurveyed after an interval of ten years. There was substantial turnover of hosts in the decade, and increasing disparity in the density of both infected trees and mistletoes between the elevated western block compared to the adjacent valley slopes to the east, with more than five times the density of infected trees and ten times more mistletoes in the west. Different potential host densities between the sites do not explain the differences in infection rates. (*The Victorian Naturalist* **124** (1), 2007, 27-32).

Introduction

Mistletoes have an intriguing biology – they are hemiparasites (they photosynthesise, but obtain their moisture and nutrient requirements from their host), that rely, at least in southern Victoria, on the Mistletoebird *Dicaeum hirundinaceum* to spread their seed. While mistletoe has often been seen as a pest, recent work indicates that mistletoes are important components of woodland and forest ecosystems (Watson 2001). They provide reliable nectar and fruit resources, often when little else is available, and shelter and nest sites for birds. Possums preferentially browse on mistletoe, and a number of species of butterfly rely on mistletoes as a host for their caterpillars.

Some mistletoes are host specific, but most species can parasitise a number of genera (Downey 1998). Creeping Mistletoe *Muellerina eucalyptoides* has successfully adopted a number of introduced deciduous tree genera as hosts in suburban Melbourne. The lack of leaves on the hosts in winter, and the closely spaced suburban street network means that surveying for mistletoes in the suburbs can be considerably more efficient than in native forests.

In 1997, *The Victorian Naturalist* published a special edition on mistletoes (Vol. 114 (3)). Included in the collection was a paper (Seebeck 1997) reporting on the distribution of Creeping Mistletoe *Muellerina eucalyptoides* growing on introduced host trees, primarily Cherry Plum *Prunus* sp., Plane Tree *Platanus* sp., Oak *Quercus* sp., Elm *Ulmus* sp. and Birch *Betula* sp. in a 300 hectare area of suburban Heidelberg, north of Melbourne. There have been few studies into changes in the spatial distribution of Australian mistletoes, so the inclusion of a detailed distribution map in that paper (Fig. 1) suggested a follow-up study to investigate changes in host distribution and infection patterns over the intervening decade.

Study area and methods

The study site spans the uneven rectangle bounded by Waterdale Road to the west and Rosanna Road to the east, and Southern Road and St James Road to the north and Banksia Street to the south (Fig. 1). The area is divided into two approximately equal blocks by Upper Heidelberg Road/Waiora Road, which runs north-south through the site, and which also forms a topographic boundary between the relatively flat elevated area to the west, and the slopes descending to the Yarra River to the east.

The area is a mix of older residential housing surrounding Burgundy and Bell Streets, and post Second World War suburban housing to the north, with scattered parks and some light industrial areas and shopping strips along the major roads. Little native vegetation grows within the area, apart from a small number of old eucalypts between Brown Street and St James Road.

Following the methodology of Seebeck (1997), each street was surveyed from a slowly moving vehicle in August 2005, when the lack of leaves on deciduous trees facilitated the detection of mistletoes. Roadside trees and private gardens were surveyed, but the two campuses of the Austin Hospital (Austin and Repatriation) were not. Mistletoes in evergreen trees were not surveyed. Each distinct clump of mistletoe was recorded, along with the host tree genus, and the position was logged using a Global Positioning System (GPS) unit. Since Creeping Mistletoe may have a creeping habit along the branches of its host, these clumps may not represent distinct individuals, but for the purposes of this paper they are considered as such. Where trees were heavily infested or observations were doubtful, closer inspection on foot and/or with binoculars was carried out. Host trees could generally be identified by morphology and bark. Doubtful identifications were rechecked when the plants were in leaf in April 2006.

Within the east block (area =1.428 km^2) 18.69 km of road was surveyed, representing a survey effort of 13.09 km per km^2. In the west (area =1.337 km^2), 21.61 km of road was surveyed, representing a survey effort of 16.16 km per km^2, a slightly higher figure than in the east due to the subdivision geometry.

In April 2006 a further survey was undertaken to establish the density of potential host trees in the area. Approximately 20 percent of the roads (4.148 km in the east, and 5.444 km of road in the west) in each block were surveyed from a slow-moving vehicle, and the genus and location of each potential host tree was recorded and logged with a GPS unit.

Results

Mistletoes

The location of infected trees is shown in Fig. 2. Infected street trees are plotted at the actual location (typically accurate to +/- 10 m using the GPS), but those occurring on private property are plotted at the nearest point on the street, and may be up to 30 metres from their actual location.

Mistletoe and infected tree densities are shown in Table 1. These figures may under - represent the true densities, since buildings and foliage, particularly in back and side yards, may have obscured mistletoes and host trees occurring on private property. Since the survey effort differed in the two blocks, the most accurate measure for comparison of mistletoe and host density is

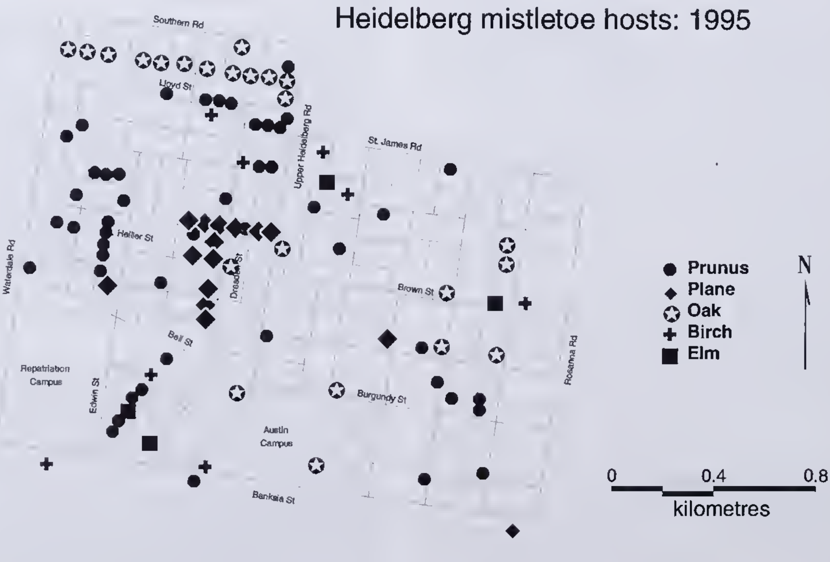

Fig. 1. Map showing distribution of mistletoe hosts in 1995.

Table 1. Density of infected hosts and mistletoes

Block	Number of hosts	Hosts per survey kilometre	Number of mistletoes	Mistletoes per survey kilometre
East	30	1.61	61	3.26
West	153	7.08	715	44.24

Table 2. Density of potential host trees

Block	Number of potential host trees	Survey distance (km)	Potential hosts per survey kilometre
East	130	4.148	31.34
West	141	5.444	25.90

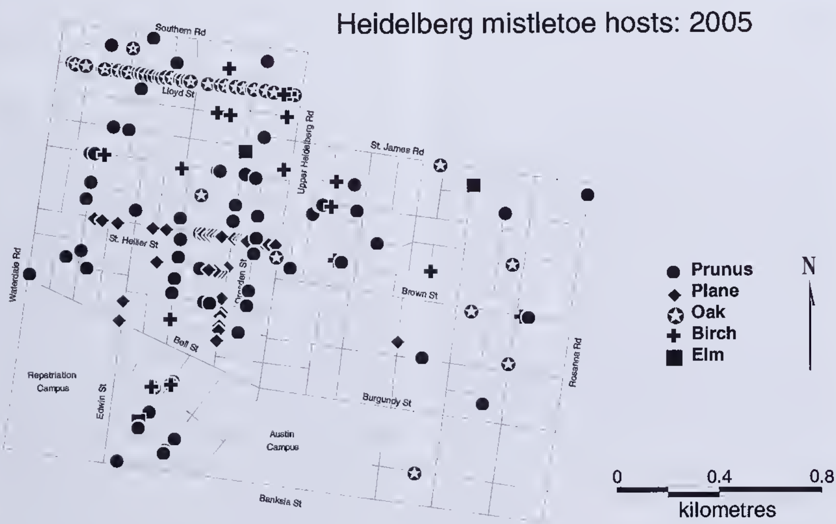

Fig. 2. Map showing distribution of mistletoe hosts in 2005.

mistletoes per survey kilometre and hosts per survey kilometre.

In the west block there were more than five times as many infected trees and more than ten times the density of mistletoes compared with the east black, both in absolute terms and relative to survey effort.

Potential host tree densities

The number of potential host trees per kilometre of survey in each block is shown in Table 2.

Incidental observation indicated that different host genera might have differing susceptibility to infection. If one area had more hosts of a particularly susceptible genus, then that might give rise to greater infected host densities in that area. A comparison of potential host density with actual host density by host tree genera between the east and west blocks indicates that differences in potential host densities between the blocks does not explain the marked difference in infected host density between the blocks (Fig. 3).

While relative densities of cherry plum are comparable across the blocks (black dots, left hand axis), actual infection rates (open squares, right hand axis) are consid-

erably lower in the east block. Birch and oak densities in the east are more than twice those in the west, but infection rates are approximately three times lower. These results should be treated with caution for some genera. Plane trees, and to a lesser extent oaks, occur as discrete patches of street plantings, leading to a very 'lumpy' distribution across the study site, and the potential host survey, which only sampled a portion of each block, may have mis-represented the actual density of these genera in the blocks. Since cherry plum, birch and elm are more evenly dispersed across the area, they are considered unlikely to suffer from this limitation.

Changes in infection patterns, 1995 – 2005

A direct comparison of changes in the spatial distribution of mistletoes is not possible since Seebeck recorded infected host trees, rather than mistletoe plants. While Seebeck's text is not explicit, it appears that where multiple mistletoes occurred in an individual tree, only the host tree was recorded rather than the number of mistletoes within the host. The map included in that paper is also incomplete, since not all host trees bearing mistletoe referred to in the text appear on the map, for what appears to be reasons of cartographic simplicity. Where dense clusters of infected trees occurred, some cartographic licence seems to have been used, and the number of points shown on the map is less than the number of infected trees referred to in the text. Where the infected trees are more dispersed it is probably safe to assume that all of the infected trees were plotted on the map.

In spite of uncertainty in re-identifying some of the hosts in the older study, most individual hosts – particularly where only a single mature specimen of the host genus occurs in a location – can still be identified (Tables 3 and 4). If the Seebeck map is generally reliable, then overall mistletoe infection rates in the east block (where no dense clusters of infected trees occur) appear to be relatively stable, but with a considerable turnover in hosts.

No clear spatial pattern in persistence, abandonment or recruitment of mistletoe hosts in the east block was evident.

The picture is less clear in the west block. Since a high proportion of infections in the west block occur in tight clusters, estimates of persistence, recruitment and abandonment within these patches are unlikely to yield reliable data. The incomplete data included in the Seebeck map further complicates the issue. The data presented in Table 4 are only indicative of changes in the dispersed host areas outside of the clustered infection areas.

However, within these dense clusters changes can be inferred from Seebeck's text. Mistletoes in the row of oaks along

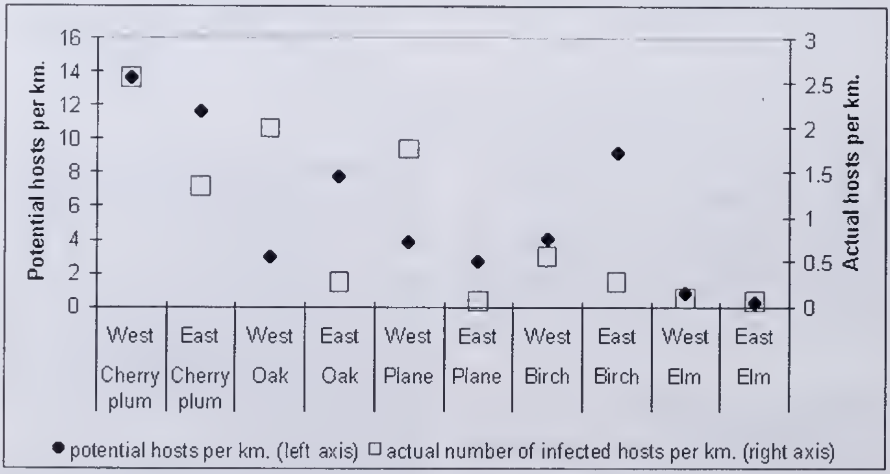

Fig. 3. Comparison of potential hosts and infections by genus, east and west block.

Table 3. Changes in host trees, East Block, 1995-2005.

Genus	Persistent host	Abandoned host	New host
Cherry plum	4	6	9
Elm	0	1	1
Oak	2	3	2
Birch	1	1	2
Plane	1	0	0
Other	0	0	2
Total	8	11	16

Table 4. Changes in dispersed host trees, West Block, 1995-2005.

Genus	Persistent host	Abandoned host	New host
Cherry plum	11	23	41
Elm	1	1	1
Oak	0	2	4
Birch	2	3	8
Plane	0	0	0
Other	0	0	3
Total	13	29	57

Lloyd St have expanded west from the original 15 hosts (out of 49) clustered at the east end of the street, to 39 infected trees (although Seebeck's map only shows 12 hosts).

Similarly, in the line of plane trees in Saint Hellier St, the mistletoe population has expanded from nine trees clustered toward the east end of the street, to 21 hosts, with the infection spreading west along the plantation. The group of mistletoes in the Dresden St plane tree plantation has expanded south and increased from the original six trees to nine (out of 17). However, in the nearby group of nine similarly aged planes in Edwin St infected trees have increased from only one infected tree to two.

Apart from a trend in host cycling similar to that noted in the east block, there appears to be a spread of infection from the high density patches at the east of the block toward the less densely infected areas to the west.

Discussion

While this research has shed some light on the distribution patterns and changes in mistletoe host density, it raises a considerable number of questions regarding the causes of the differences between the blocks.

The difference in density between the east and the west may be just a chance occurrence, but the fact that the pattern has persisted over ten years, while there has been considerable turnover in the mistletoe population, suggests this is not the case. The increase in infected trees in the west, while infection levels in the east have remained relatively stable, lends weight to that view.

Like any organism, the population of mistletoes is a function of the balance between recruitment and mortality. In the case of mistletoes, however, this is complicated by reliance on a specific vector (Mistletoebirds, *Diaceum hirundinaceum*) for spread, and host specificity for establishment.

From the data presented here, potential host densities are not the cause of differences between the blocks, since more potential hosts occur in the east where there is less mistletoe. Underlying geology and tree cover density (Müller, in prep.) appear not to be the causative factors either.

The differences may lie in the biology and behaviour of the vector or population control agents, or microclimatic differences arising from the topography that affect mistletoe establishment or vigour. Perhaps Mistletoebirds prefer the elevated area to the west of Upper Heidelberg Road to the valley slopes to the east. Department of Sustainability and Environment database records shed little light on the issue of Mistletoebird visitation, with only three

records for the study area, all in the east block.

Differential distribution of possums, implicated as mistletoe control agents in other studies (Reid and Yan 2000) may be the cause. Again, records in the Department of Sustainability and Environment database are sparse. Only four records for Common Brushtail Possum *Trichosurus vulpecula* and three of Common Ringtail Possum *Pseudocheirus peregrinus* occur in the study area. Anecdotal reports from residents and the local municipality suggest that possums are fairly widespread although no quantitative data are available.

The apparent spread of mistletoes into previously unoccupied hosts in the west block indicates an increase in recruitment occurring in the west block but not in the east. This may be due to chance, to changed circumstances occurring over the past decade in the west but not the east, or alternatively, because long-term equilibrium in the mistletoe population has not yet occurred in the west block.

Anthropogenic factors may be another causative factor. Differences in gardening habits and choices, behaviour, and pet choices – which may influence both Mistletoebirds and possums – may all have some influence on mistletoe distribution.

Mistletoes are considered to be keystone resources in forests and woodlands (Watson 2001) and the same may hold for urban ecosystems. If this is true, then mistletoes on introduced trees may be a critical element in establishing and maintaining diverse ecosystems in our cities and towns, particularly since the densities reported here are considerably higher than I have observed for Box Mistletoe *Amyema miquelii* in forests in central Victoria (unpubl. data).

The high visibility of mistletoes in deciduous trees during winter makes mistletoe study in urban areas considerably easier than in native forest settings. The relatively good historical records that exist for urban areas, and the ease of access and large number of potential observers in these locations suggest that the suburbs may be a prime location for untangling the complexities of mistletoe ecology.

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A Valentine's Day poem

Goodenia ovata is yellow in flower
As bright as my love, for you every hour
While the Common Hovea is purple in hue
(Well it's actually mauve, between me and you)
The *Caladenia rosella* has petals of red
'Tis the colour of passion, it's often been said
But the best plant of all for the job of type-casting
Is the *Bracteantha bracteate* – the Golden Everlasting
Its name says it all, in colour and style
Like my love, it is pure and goes on all the while

written by one of the Editors
for his wife

An addition to the snake fauna of Victoria: De Vis' Banded Snake *Denisonia devisi* (Serpentes: Elapidae) Waite and Longman

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Abstract
In late November 2005 a survey was carried out for Common Death Adder *Acanthophis antarcticus* on Lindsay and Wallpolla Islands along the Murray River. No sighting of this species were made but a De Vis' Banded Snake *Denisonia devisi* was collected, representing the first record of the species in Victoria. Further specimens of the snake were recorded locally in other surveys, pointing to the value of baseline survey. Ongoing surveys of herpetofauna are essential and until more is known of the conservation status of De Vis' Banded Snake in Victoria; caution is recommended regarding landuse that could potentially threaten the species. (*The Victorian Naturalist* **124** (1), 2007, 33-38)

Introduction

Knowledge of the distribution of Victorian herpetofauna continues to be refined from data collected during fauna surveys and incidental records. Historical data suggest that the Victorian terrestrial snake fauna consists of some 25 species belonging to three families – Boidae, Typhlopidae and Elapidae (Coventry and Robertson 1991). However, the often cryptic habits of snakes, the distributional proximity of several apparently 'non-Victorian' species to this state, and the presence of suitable habitat for these taxa, suggests that unrecorded species may yet be found within Victoria. Here the discovery of a snake species previously unknown from the state is reported.

The Common Death Adder *Acanthophis antarcticus* is known from Victoria, having been recorded at Lake Boga by Gerard Krefft in 1856 (Coventry and Robertson 1991). However, no specimen has been collected within the state. In late November 2005 a survey for this species was undertaken on Lindsay and Wallpolla Islands along the Murray River in far north-western Victoria, following recent, unsubstantiated sightings. Over five days and three nights, a range of areas on these islands was surveyed using four techniques – raking of litter and coarse debris, rolling of logs and rubbish, deploying a sniffer dog ('Gus', a 10 month-old Beagle trained to detect Death Adders) on a lead, and spotlighting after dark using vehicle headlights and hand-held spotlights. We focused on Lignum and River Red Gum habitats because the local Death Adder sightings had occurred in these vegetation communities.

Death Adders were not detected during this survey, but on the final night a De Vis' Banded Snake (also known as a 'Mud Adder') *Denisonia devisi* was collected, representing the first record of the species in Victoria. Subsequent trips to the same and nearby areas have resulted in further records of De Vis' Banded Snakes

Observations

On November 25, at 11.10 pm (Eastern Daylight Saving time), whilst spotlighting beside a waterbody on Dedman's Track in River Red Gum forest in Wallpolla Island State Forest, approximately 800 m south of the Murray River, the first De Vis' Banded Snake was found. The area had been subject to recent earthworks involving channel and levee modification, and had received pumped water over previous months. The weather was cool and overcast, with no moon, and a cool, moderate breeze. The

day and evening had been hot and humid with some showers and lightning, followed by a cool southerly change about 1.5 hours before the snake was found. The temperature was not recorded at the time, but the maximum temperature at nearby Lake Victoria on November 25 was 35.5° C, and 14.5° C at 9.00 am the next day.

When first observed, the snake (Fig. 1) was stationary with its body in loose curves. It was lying on a flat log at the water's edge, approximately 15 cm from water and 10 cm above the water level. The immediate surrounding area had sparse litter with no grass or shrubs, and the nearest vegetation was regenerating Red Gum approximately 1–2 metres from the snake. Because they are known to be the preferred prey of this snake, we noted all frog species seen and/or heard nearby. Two species, Peron's Tree Frog *Litoria peronii* and Barking Marsh Frog *Limnodynastes fletcheri*, were calling from the waterbody where the snake was found.

In mid December 2005 a second survey resulted in a further five sightings of De Vis' Banded Snakes, four of which were found very close to the location of the first specimen. One of these snakes was dead and partly decayed when discovered in sparse Red Gum litter on a raised bank approximately 45 m from the water's edge. All three live specimens were close to the water's edge (0.02–3 m) and were found lying on dry, cracked clay, thick litter, and wet clay respectively. The second of these individuals was collected and subsequently lodged as a voucher specimen at Museum Victoria (specimen number NMV D74160; Table 1). Frog species recorded at the sites where these snakes were found included Peron's Tree Frog, Barking Marsh Frog, Plains Froglet *Crinia parinsignifera* and Spotted Marsh Frog *Limnodynastes tasmaniensis*. The last De Vis' Banded Snake found on this survey was recorded on the bank of Potterwalkagee Creek, more than 40 kms west of the previous records. The anterior half of this snake was hidden in thick, wet Red Gum litter approximately 10 cm from the water's edge under a Red Gum tree. The only frog species recorded at this site was Peron's Tree Frog.

A third survey trip in January 2006 resulted in another three records of De Vis' Banded Snakes from the western end of Horseshoe Lagoon on Wallpolla Island. These snakes were all found on bare, cracked clay within 3 m of the water's edge. Two were found on the bank of a lagoon, and one on the bank of a channel, and all were in habitat with sparse River Red Gums and *Typha* thickets nearby. Frog species recorded nearby included Barking Marsh Frog, Spotted Marsh Frog, Peron's Tree Frog and a Growling Grass Frog *Litoria raniformis*.

Frog surveys led by Sharada Ramamurthy (Mallee Catchment Management Authority) in February and April 2006 resulted in observations of another three De Vis' Banded Snakes (specimens 10–12 in Table 1) in the region, but these were not captured and there is no morphometric data for them. The first of these snakes was found in cracks in the clay substrate of a drying lagoon, approximately 200–300 m from water. The lagoon was fringed by River Red Gums, although the immediate location of the sighting had almost no leaf litter. Frogs detected at this site included Growling Grass Frog and Barking Marsh Frog. The second snake was found moving through sparse herbaceous vegetation on a clay lagoon bank with medium to dense leaf litter, approximately five metres from water. Nearby habitat consisted of numerous River Red Gums with coarse, woody debris beneath. Three Growling Grass Frogs and three Barking Marsh Frogs were observed nearby. The third snake was found moving through leaf litter on the bank of a wetland approximately seven metres from water. The immediate area had a medium cover of leaf litter, sparse herbaceous vegetation and River Red Gums over a layer of coarse, woody debris. Several Peron's Tree Frogs were observed nearby.

Available morphometrics of these snakes are presented in Table 1. Apparent signs of sexual dimorphism permitted the tentative assignment of sex presented in the last column. Snakes believed to be females had tails that tapered uniformly from the vent, with no signs of hemipene bulges, and their tails were usually noticeably shorter (with less subcaudal scales) than the snakes considered to be males. Similarly, two of the three snakes considered to be females had

Table 1. Collection and morphometric details of De Vis' Banded Snakes *Denisonia devisi* from north-western Victoria. Time is Eastern Daylight Saving time. Temperatures in parentheses were not recorded immediately at the time of observation. Length is given in millimetres, weight in grams. In all specimens the anal scale is single. Specimen 3 was dead and partly decayed when found.

Specimen number	Collection date, time and ambient temperature	Locality	Snout-vent length	Tail length	Weight	Mid-body scale rows	Ventral scales	Subcaudal scales	Likely sex
1	25 November 2005, 2310 hrs	'Lillyponds' Wallpolla Is.	354	44	32	17	134	24, all single	Female
2 (specimen lodged with Museum Victoria)	13 December 2005, 2305 hrs, 22.1°C	'Lillyponds', Wallpolla Is.	334	59	22	17	129	32, first divided, rest single	Male
3	14 December 2005, 1200 hrs	'Lillyponds', Wallpolla Is.	N/A	N/A	N/A	N/A	N/A	N/A	N/A
4	15 December 2005, 2225 hrs, 24.9 °C	'Lillyponds', Wallpolla Is.	336	43	22	17	136	26, all single	Female
5	15 December 2005, 2230 hrs, 24.9 °C	'Lillyponds', Wallpolla Is.	322	41	25	17	134	26, all single	Female
6	16 December 2005, 2240 hrs, 22 °C	Potterwalkagee Creek, ~1 km downstream of old Ned's Corner pumphouse	371	51	23	17	128	33, first divided, rest single	Male
7	21 January 2006, 2229 hrs, (36.5°C at 2245 hrs)	Western end of Horseshoe Lagoon, Wallpolla Island	286	46	17	17	128	33, first divided, rest single	Male
8	21 January 2006, 2245 hrs, 36.5°C	Western end of Horseshoe Lagoon Wallpolla Island	N/A – snake not captured	N/A	N/A	N/A	N/A	N/A	N/A
9	21 January 2006, 2256 hrs, (36.5°C at 2245 hrs)	Western end of Horseshoe Lagoon Wallpolla Island	N/A – snake not captured	N/A	N/A	N/A	N/A	N/A	N/A
10	14 February 2006, 2319 hrs, (24.2°C at 2325 hrs)	South-eastern end of Snake Lagoon, Mulcra Island	N/A – snake not captured	N/A	N/A	N/A	N/A	N/A	N/A
11	24 February 2006, 0022 hrs, (29.7 °C at 2335 hrs 23 February)	South-eastern end of Snake Lagoon, Mulcra Island	N/A – snake not captured	N/A	N/A	N/A	N/A	N/A	N/A
12	14 April 2006, approximately 2100 hrs, estimated 10–15 °C	Western end of Potterwalkagee Creek, Mulcra Island	N/A – snake not captured	N/A	N/A	N/A	N/A	N/A	N/A

three to four bulges in the posterior half of the body, suggesting that these specimens were gravid. These apparent differences between the sexes coincided with a divided first subcaudal scale in those considered to be males, whereas this scale was single on those considered to be females. Lastly, these characters suggest that the specimen that was lodged at Museum Victoria would be a male. Subsequent examination of the post-anal musculature and probing of probable hemipenis pockets of this specimen confirmed that it was a male (J Melville pers. comm.).

Discussion

These are the first records of De Vis' Banded Snakes from Victoria, and represent a significant south-westerly range extension for this snake. The species' previously known range was north-central New South Wales extending north into south-central Queensland, closely associated with the riverine habitats of the upper Darling River system. The late Charles Tanner spoke of an observation he made around 40 years ago of a De Vis' Banded Snake some 100 km north of Wentworth, New South Wales (pers. comm. to AJC), and more recently PR received a report of a juvenile from the vicinity of Wentworth. These two observations have been treated with some reservation, but the records presented here apparently validate these earlier reports. A recent sighting of a Common Death Adder on Wallpolla Island now seems erroneous and, after checking with our photographs of De Vis Banded Snakes from Wallpolla Island, is more likely to have been this species (J Dzuris pers. comm. to NC). Consequently, it is conceivable that De Vis' Banded Snake not only occurs in the floodplain environs of far north-western Victoria, but also those within the Darling River catchment in central and southern New South Wales.

The closest official records of De Vis' Banded Snake are more than 500 km distant (in the vicinity of Bourke, New South Wales; Swan *et al.* 2004), with only a couple of unsubstantiated sightings (above) of the species in the south-west of that state. Interestingly, the species has not been detected during several recent fauna surveys that sampled riverine habitats in the lower reaches of the Murray Darling catchment in Victoria and New South Wales (Robertson *et al.* 1989; Coventry 1996; Val *et al.* 2001; Brown *et al.* 2003; Robertson and Silveira 2005, PR unpubl. data). The discovery of this snake in Victoria suggests that commonly used reptile survey techniques may easily miss this species. De Vis' Banded Snakes inhabit cracking, clay-based soils on alluvial flats (Wilson and Swan 2003), a habitat that is frequently avoided during pitfall trapping (the most commonly applied technique in the studies listed above) because of the difficulty of digging in these types of soils, and the problems associated with flooding of the traps. De Vis' Banded Snake is a nocturnal, frog-eating species (Shine 1983), and is perhaps best surveyed by spotlighting wetland habitats close to the water's edge during the warm, humid and/or rainy conditions favoured by their prey.

Despite the studies listed above, this part of far north-western Victoria (as well as adjacent parts of New South Wales and South Australia) has not been surveyed thoroughly. The records presented here, and the results of other recent studies (e.g. Clemann *et al.* 2005), demonstrate that baseline surveys frequently provide valuable information and significant new data on notable species. Consequently, we recommend that government agencies and management organisations continually strive to refine their understanding of species' distributions. Furthermore, recognising that landscapes and habitats are dynamic and continually changing, repeat surveys over time will be necessary if we are to understand changes in species' occupancy and distribution, and the reasons for these changes.

The observations on the morphology and habitat use of these Victorian De Vis' Banded Snakes conform to those previously recorded for the species in Queensland and New South Wales, with snakes occurring in floodplain habitat with deep alluvial clays and riverine woodland vegetation (see Cogger 2000, Wilson and Swan 2003, Swan *et al.* 2004). Similarly, these Victorian specimens were found at night close to the edge of wetlands with abundant frogs. This is in accord with the nocturnal, frog-eating habits of the snake pre-

viously reported in the literature (Shine 1983). The apparently gravid condition of some of these snakes suggests an early spring mating period, in accordance with specimens from New South Wales and Queensland (Shine 1983).

The morphometric and scale count data that we recorded are within the ranges presented for this species by Greer (1997) and Shine (1983). However, the observation of divided first subcaudal scales in specimens that were apparently males has not been noted previously. The consistency of this trait amongst Victorian specimens, and whether this feature has been overlooked in specimens from other states, remains to be confirmed.

Reed and Shine (2002) identified ecological correlates of threatened status amongst Australian elapid snakes, and suggested that De Vis' Banded Snake, although not listed as threatened, exhibited traits typical of other, threatened species. Considering the then known distribution and status of the species, Reed and Shine (2002) interpreted the inclusion in their analyses of this species with officially threatened taxa as perhaps being pre-emptive (i.e. they suggested that De Vis' Banded Snake, and several other species, may be sensitive to threatening processes, but were yet to manifest such sensitivity). Our discovery of what may be a small and isolated population of this species suggests that this interpretation of Reed and Shine (2002) may be prophetic, and should heighten concern for the conservation of De Vis' Banded Snake in Victoria. Consequently, we suggest that a thorough appraisal of the species' status in the area is needed, and a precautionary approach to protecting its habitat and that of its amphibian prey be adopted.

Until such time as adequate research is conducted to determine the ecological and conservation requirements of De Vis' Banded Snake in Victoria, it is recommended that potentially threatening activities, particularly cattle grazing, logging and firewood removal, be controlled, and their effects monitored, in riverine habitats in the north-west of the state. Removal of these potentially threatening processes also would benefit the conservation of other threatened snake taxa in the region, including the Red-naped Snake *Furina diadema*, Curl Snake *Suta suta* and Inland Carpet Python *Morelia spilota metcalfei*. These species occur in the area in which the De Vis' Banded Snakes were recorded (Coventry and Robertson 1991; Atlas of Victorian Wildlife database), and in similar broad habitats, suggesting that riverine habitats in north-western Victoria are important for snake conservation in this state.

Surveys of herpetofauna should be an essential ongoing component of biodiversity conservation programs in Victoria. There are other snake species not recorded in Victoria that occur tantalisingly close to this state, and, as suggested by Coventry and Robertson (1991), some of these yet may be detected during targeted surveys.

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Woodlands: a disappearing landscape

by David Lindenmayer, Mason Crane and Damian Michael

Photographs by Esther Beaton
With contributions from Christopher MacGregor and Ross Cunningham

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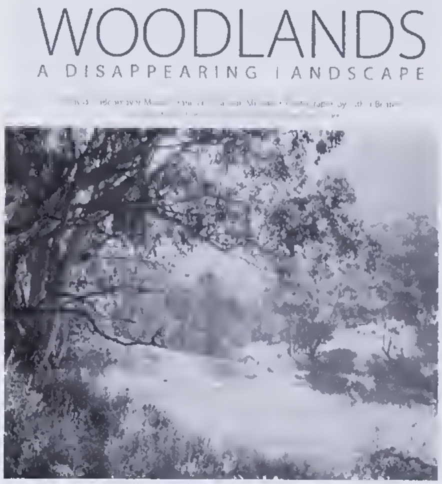

The wonderful woodlands of south-eastern Australia are not at the forefront of people's minds when conjuring up images of Australia's world-renowned natural environment.

For a long time, woodlands have been relegated down the list of preferred vegetation communities. The very zen-like structure of woodlands, and the gentle landscapes in which they occur have, sadly, contributed to their downfall. Their park-like appearance drew anglophiles of the 18th and 19th centuries, and the ease with which they could be cleared made them susceptible to further degradation.

This is where *Woodlands: a disappearing landscape* comes in. The book takes you on a journey through Australia's woodland heritage, and the seasonal and structural components of the woodlands, paying attention to many different aspects of the woodlands, both biotic and abiotic. This book takes you from the canopy to the ground layer, exploring the world beneath the bark of ancient gums, the cool mud of swampy wetlands, and the fine construction of a Willie Wagtail's nest. As soon as you read this beautifully presented special interest book you'll be planning your next picnic or bushwalk.

This book targets a wider audience than the scientific community – it has its roots in science, but appeals to the general community through the use of stunning photographs, diagrams and easy to follow chapters and subheadings. My favourite photo is of a Cunningham's Skink basking on a rock beneath a brooding stormy sky (page 81).

The authors go far beyond the stereotypical aesthetic appeal of our natural environment, evidenced by the attention paid to invertebrates. Witchetty grubs, centipedes, jewel spiders and golden orb spiders are just a few of the many invertebrates featured in the colourful photographs, as well as being discussed in the text.

This book does not aim to be a scientific reference, although it does draw on some excellent resources, imploring the reader to study further. The bibliography spans seven pages, and is broken into subheadings including Mammals, Frogs and Reptiles, and Plants, with the largest section being Background Scientific Literature. The final two chapters, (Woodland Management and Conservation and The Future) are the most pertinent, as the authors venture beyond dire forecasts and faint messages of hope. Instead, concise, proven actions are provided for those striving to do more for these wondrous landscapes. These actions are summarised well on page 132, and include steps such as 'Consider the size and shape of planting' and 'Leave dead saplings and trees as well as fallen branches and logs within restored areas – they will have important habitat value'.

Woodlands: a disappearing landscape has broad appeal, but in its final chapters funnels a range of information into a very precise direction, which is to ensure that future generations can enjoy woodlands as much as we do. It would be ideal for landowners who wish to learn more about and enhance the woodlands on their properties, and would be well received by any naturalist.

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As if for a thousand years: a history of Victoria's Land Conservation and Environment Conservation Councils

by Danielle Clode

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The Land Conservation Council (LCC) (1971–1997) and its successors, the Environment Conservation Council (ECC) (1998–2001) and the Victorian Environmental Assessment Council (VEAC) (2002–present) are a 'uniquely successful public land planning system like no other in the world' (p. 136), so a good history of decision-making about thc most appropriate use of public land is both valuable and timely. Clode's scholarship is accessible, data-rich, informative and readable.

Histories of public institutions, particularly those commissioned or published by the institutions themselves, have a high risk of being sanitised 'spin'. Clode avoids this by skilfully interweaving insightful and frank comments of both the political and other players (e.g. Ministers Borthwick and Kirner, Calder) into a readable 'story'. The socio-political milieu in which the institution was created is very well covered and the context of subsequent changes is well explained. After the Little Desert debate of the late 1960s (to clear or not to clear?), Bill Borthwick became Minister of Lands, Soldier Settlement and Conservation (*my how we have changed*).

He legislatively created and subsequently defended the independence of the LCC. Clode enlivens the text with personal communications of this far-sighted politician to whom the book is appropriately dedicated and whose words provide the title.

Apart from reflections of various 'players', the dryness of strict chronology is avoided by other techniques. Comments on the LCC reports of each study area, linked to their reviews and new innovations, are discussed in separate boxes at the end of each chapter. Important themes such as mapping of vegetation ('structural' suited foresters, while floristics suited the botanists and evolved into Ecological Vegetation Classes) are discussed in the context of information bases. Apart from the extensive tables and Figures, the Appendices (A-G) provide a wealth of detailed information including the Acts and personnel (Councillors and *all* staff) by year. There is also an index, always useful for ongoing reference.

Institutions are led by people and Clode illustrates how successive Chairmen (Dimmick, Scott and Saunders) were able to bring their strengths (and weaknesses) to the evolving institution that, whilst independent, worked 'within the confines of Government policy'. For example, after a Research Officer's initial greeting of '*Pleased to meet you Sam*', he was not spoken to by Chairman Dimmick for his entire three years at the LCC (p 51) – which was a *very* small organization. Scott would defend Dimmick's hard-won independence, yet added more successful consultation to the mix, which 'was one of the defining features of the LCC' (p 67). This consultation also assisted public education and thus resolution/acceptance of sometimes controversial decisions.

Efforts of the Field Naturalists Club of Victoria and Victorian National Parks Association at strategic periods illustrate how the community can affect the shape and direction of institutions. Broader community and institutional changes are woven into the story providing perspectives that strengthen the analysis (e.g. 'planning' of the 1960s and the rise of 'managerialism' from the 1980s onward at the expense of technical expertise). This allows the author to explain the evolution of the institution and yet maintain a critical eye.

In Chapter 9 it is suggested that the functions of the LCC and ECC were relatively similar, and differed only in the particular emphasis accorded to 'development' in the ECC's functions. However (as seen from the Appendices), a major difference was that the LCC's function was to recommend on the 'use of public land with a view to the *balanced use of land* in Victoria' whereas the ECC was required to recommend on the 'balanced use of public land'. The latter is often stated as the LCC's function but this was not so, as Chapter 2 discusses. It is unclear whether the different wording in the ECC functions was inadvertent or deliberate. Interestingly, the proposed legislation for VEAC was to include private land. However, the revised Act limited it to public land.

The book is well presented and laid out, although the photographs appear biased toward the more recent, and Chapter 1 has several references that do not appear in the reference list. More seriously, contemporaneous with the LCC there was a national debate on indigenous land rights and related issues. Clode notes that the LCC expanded consultation with traditional Koori owners from the early 1980s; however, establishment of reserves (including reserved forest) and parks over uncommitted crown land before 1994 (LCCs *raison d'etre*) would inadvertently adversely affect the Koori's native title rights under the *Native Title Act*, which flowed from the Mabo decision (1992). Discussion of this important theme is a surprising gap in an otherwise scholarly work. Clode's book will become an important reference about a significant institution.

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Flora of the Otway Plain and Ranges 1. Orchids, Irises, Lilies, Grass-trees, Mat-rushes and other petaloid monocotyledons

by Enid Mayfield

Publisher: *Linton Press, Geelong, 2006. 219 pages, paperback; colour illustrations. ISBN 0977571203. RRP $45.00*

This book will be a delight to use for people interested in the native plants that occur in the floristically rich Otway region that extends west of Melbourne to as far as Portland. It is an area that to date has not received its own flora treatment. Many of the plants included are among Victoria's most rare and endangered.

The first volume includes over 130 species of orchids, as well as a full treatment of members of the iris and lily families, grass-trees and mat-rushes. A second volume, already in preparation, will cover the herbaceous and shrubby dicotyledons.

The book is both a flora and a field guide. For every plant you will find all the information you expect in such publications. The essence of this book, however, is that it is visual: even the several keys use pictures to impart crucial information. Complex taxonomic concepts are explained by the use of clear illustrations. Each species is described in accessible language, and technical terms are explained in an illustrated glossary. Integral to the descriptions are coloured drawings of the key features of each species. Unique for this type of work is the inclusion of illustrations of the insect pollinators, fruits, seeds and root systems.

The author is Enid Mayfield, a botancial artist who enjoys a high reputation for her exact and exquisite scientific illustrations. Her work is informed by her meticulous observation of the form of the plants, and extensive fieldwork backed by examination of relevant literature. Essential for her work were the *Flora of Victoria* and *A census of the vascular plants of Victoria*, both produced by the Royal Botanic Gardens Melbourne. Most of the plants illustrated in this book were drawn from live specimens collected in the field by Mayfield after examination of herbarium records to determine where species occurred. In the few instances where a species proved elusive she used herbarium specimens to prepare her painting, in itself an exacting task.

Throughout, Mayfield consulted taxonomic botanists at the Royal Botanic Gardens Melbourne, experts in particular groups of plants, naturalists with local knowledge of her study area and entomologists at Museum Victoria. The book is a testament to the spirit of collaboration that exists in the community of people interested in Victoria's natural history.

The rigorous scientific basis of Mayfield's work has come to fruition in preparation of this *Flora*; the depth of her scholarship will be apparent to those who use the book. It is delight to look at, scientifically accurate, accessible and will be welcomed by many, not just those interested in the flora of the Otway plain and Ranges.

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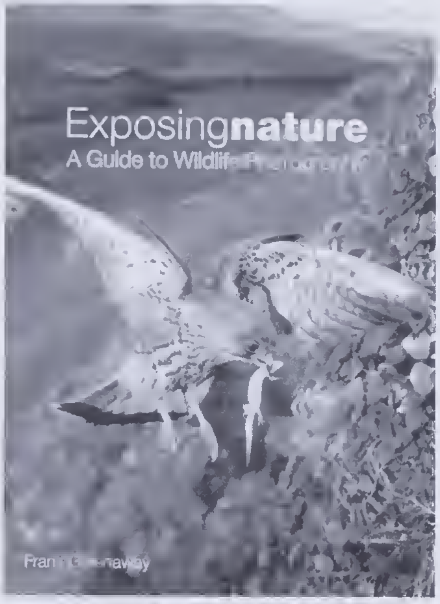
Exposing nature: a guide to wildlife photography

by Frank Greenaway

Publisher: *CSIRO Publishing, 2006. 160 pages, colour photographs. Paperback, ISBN 0643092900. RRP $49.95*



This book is a wonderful guide on how to approach photography with a view to reproduction and enlargement. For those people such as gifted amateurs and dedicated recorders of wildlife or landscapes for their own use, it is a guide to what can be aspired to if ever they had the time or patience.

The detailed and informative text begins with the need to recognise the purpose of the camera holder for taking photos. This is followed by the recommendation to have a complete knowledge of your subject so that its behaviour in its natural environment can be predicted with ease, improving the chances of taking a better photograph.

There is a section on the ethics of nature photography, and the message here – oft repeated throughout the book – is that the consideration of causing danger and disturbance to shy animals in their habitat should rank above the human need to take photographs of these species in the wild. The subject should not feel threatened by a human presence in its habitat. Where this is not possible, the techniques that can be employed, from simply disguising the camera to the equipment and set-ups required for remote operation, are discussed.

There are sections on selection of equipment, advice on lenses, flash equipment, tripods, bags and projectors as well as a useful section on autofocus, apertures and shutter speeds. There is a very helpful comparison of film and digital and even some advice on getting the most out of your compact digital camera.

Then there are the photos, a mouth-watering display of expert capability, that makes one wish to have the time and patience to achieve such rewarding outcomes. There are separate chapters for birds; mammals; reptiles and amphibians; insects and other invertebrates; water; plants; and habitats. Some problems specific to each section are discussed, such as planning a trip abroad for photographing mammals; background problems with insects; coping with reflections with water photography.

I particularly like the mammal photos, many shot at night and triggered by the animal breaking an infrared light beam. These include many examples of bats on the wing and a stunning montage of four different animals (two cats, one fox and one dog) caught passing along a regular pathway in a backyard.

This is a most enjoyable book, best suited to those readers who want to be professional wildlife photographers.

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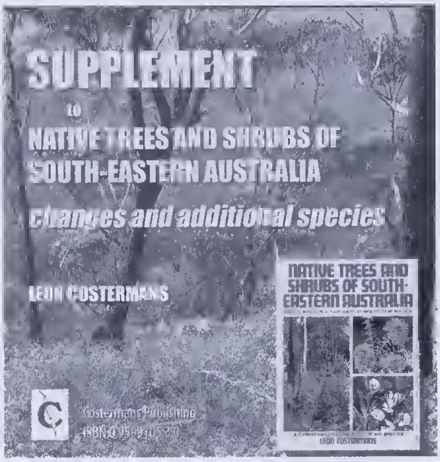

Supplement to native trees and shrubs of south-eastern Australia: changes and additional species

by Leon Costermans

Publisher: *Costermans Publishing, 2006. CD-ROM. ISBN 0959910530. RRP $25.00*

Native trees and shrubs of south-eastern Australia was first published in 1981. A revised edition was published in 1983 with only relatively minor changes. It is still in print and students lovingly refer to it as 'Costermans'. This book has become a standard reference and field guide for a wide variety of people including working botanists and ecologists, students, land managers, field naturalists and many others. And little wonder, it is easy to use, comprehensive and has good quality drawings and photographs. The many reprints since then essentially have had no changes in content other than the inclusion of brief lists of amendments in printings from 1992 onwards and a separate 8-page printed supplement was made available in September 1992, but many taxonomic revisions and descriptions have occurred since. Thus the book really should be completely revised which would be a major task taking years, over which time more changes would occur! The book also would be more expensive as it would need to be enlarged and restructured. For these reasons the author felt that the most practical and economical way to bring this book up to date with taxonomic changes was to provide a supplement on CD-ROM.

The CD-ROM contains a number of files which are listed on the back cover of the case:

1. READ ME FIRST which provides recommendations for most effective use.
2. INTRODUCTION where the author explains what brought about the need for this supplement. The author also explains in some detail why plant names change, the importance of knowing the taxonomic history of plants and how one can determine the taxonomic history using author citations, useful information for the novice or those who have not quite understood these facets within their study of botany.
3. SUPPLEMENT which consists of three versions having identical content.

- A screen version which has a smaller file allowing faster navigation
- A screen version with higher resolution photos, hence a larger file, which allows viewing of detail.
- A print version in the book's vertical format.

The supplement includes:

- Copyright conditions.
- An alphabetical listing of 378 species with hyperlinks to the pages on which they are described or photographed. Eighty species not included in the book occur on this list.
- Part A: Changes and consequent additions. This explains the many name changes that have occurred and provides additional information on many species occurring in *Native trees and shrubs of south-eastern Australia*. Each name change can be verified by the reader as reference to the author of the name change and to the journal article in which the change is described is provided with a full reference given under References in Part B. This highlights the great atten-

tion to detail that Leon Costermans is known for and which makes this CD such a valuable resource.

- Part B: 'New' species, new names for 'old' species and some additional species.
- References. This includes links to a variety of useful websites, ideal for the uninitiated in particular.
- Photographs. These are of a high resolution and can be enlarged greatly to allow critical comparison of key identification characteristics with specimens under investigation. This cannot be done with the photographs in a book.
- Map which includes all localities referred to in the supplement, a most useful resource.
- List of botanical authors

This CD will become as popular as the book to which it is a supplement. It is extremely user friendly, even to the 'CD-ROM novice'. The author explains how to use the CD in simple terms. The many hyperlinks makes navigation between sections and points of interest extremely convenient. Familiarity with Acrobat Reader, which is used by the CD, makes it even more so. For example, one can simply press on the 'find' icon (the one with the binoculars) and locate any word. The read me first file gives some basic instructions on using Acrobat Reader as well as the suggestions for most effective use of the CD, so following the author's instructions is advised.

The *Supplement to Native trees and shrubs of south-eastern Australia: changes and additional species* is highly recommended to anyone with an interest in identifying plants and, at the recommended retail price of $25.00, no-one should be without it!

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Treatment of Eucalypts in *Supplement to native trees and shrubs of south-eastern Australia*

Eucalyptus taxonomy is complex and fluid to the extent that ill-informed observers have to deal with at least three versions of eucalypts of south-eastern Australia and it is little wonder that they become confused, particularly with the many changes of names and statuses and with the regular flow of new taxa. To his credit the author has not attempted to impose his own version of the taxonomy of the eucalypts on his readers. Instead he has meticulously presented the entire range of adjustments, including concise accounts of the most recently described new taxa, and, in effect, taken a somewhat neutral position. His approach has provided an alternative perspective to the sometimes biased books and CDs which tend to peddle a particular taxonomic philosophy. His field guide offers the opportunity for the users to form their own opinions regarding the taxonomic merits of the various contentious taxa. It also provides an important level of continuity of what has now become a botanical icon.

As one who is thoroughly conversant with the recent trends in eucalyptus taxonomy and with the accompanying literature, I can attest that the author is accurate in his information. However, I must point out that he has not dealt adequately with the taxonomy of the contentious *Eucalyptus silvestris*. There are actually three versions of its status: that it is a species in its own right; that it is a form of *E. microcarpa*; and that it is a form of *E. odorata*. Whilst he has noted information given by the original author and in the Flora of Victoria (1997), he has not made references to more recent perspectives such as those by Nicolle (1997), *Eucalypts of South Australia,* and Ross and Walsh (2003), *A Census of The Vascular Plants of Victoria, Seventh Edition.* With regard to the latter, this is the Melbourne Herbarium's official account of Victoria's eucalypts.

A second concern has been that the use of photographs of herbarium specimens rather than line-drawings as supplements may decrease the visual quality of the information provided. The practice of using photographs of herbarium specimens has become common in recent taxonomic

papers and may well suit other taxonomists who are intimately conversant with subtle differences between taxa. However, I wonder whether this medium will suit the many amateur enthusiasts who have grown to depend on the author's excellent line-drawings of his previous texts. Only time will tell whether this strategy has been appropriate.

In my opinion, and with regard to eucalypts, the Supplement has been professionally assembled and presented logically. Over all, they enhance the text which will make another extremely important contribution to the education of many botanical enthusiasts and naturalists in this part of Australia. I thoroughly commend it for its treatment of an extremely complex and contentious genus and have no hesitation in recommending that it becomes a worthy addition to any enthusiast's professional library.

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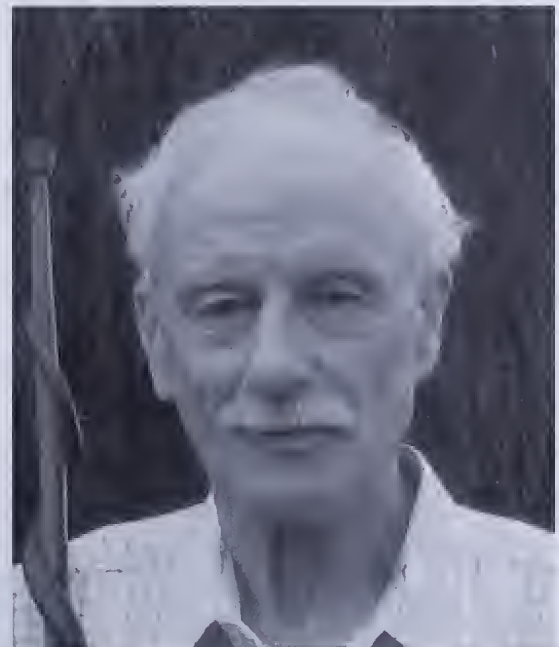
Eucalyptus Taxonomist
Email:

Dr John (Jack) Gordon George Douglas

Palaeobotanist and Naturalist

2 June 1929 – 6 February 2007



Jack Douglas was born at Colac, Victoria, to William and Lorna. He was the eldest child, brother to Elizabeth, Colin, Owen, and Ken. When the family moved to Melbourne he attended St Kevin's College and then the University of Melbourne, graduating in 1954 with a Bachelor of Science. He married Anne Moore, his laboratory assistant, in 1960 and gained great happiness from his family life – his wife of 46 years, their six children and 16 grandchildren.

In 1955 Jack began work with the Geological Survey of Victoria, specialising in fossil plants. Jack collected fossils extensively and was granted leave to undertake a PhD. He graduated in 1967. The thesis was published as a monograph that gained him a worldwide reputation. He published widely on his research into palaeobotany and palynology, with a record of more than 70 scientific papers. His booklet *What Fossil Plant Is That?*, published by the FNCV in 1983, remains as popular as ever. Jack also was a contributor to *Geology of Victoria.* He was a life member of the Geological Society of Victoria.

Jack's passion for fossil plants took him into the public arena when it became clear that a plant fossil locality near Yea was in danger of being destroyed. This locality in central Victoria contains the oldest vascu-

lar land plants in the world (420 million years old), including the world-famous *Baragwanathia*. It was Jack who pointed out to the authorities the unique value of the site, which has recently been added to the National Heritage Register.

Jack served as President of the FNCV from 1986 to 1988. This was an important time in the Club's history as it sought to reaffirm its role as the oldest continuous conservation society in Australia. When I (RW) joined the Council in 1993 Jack served as a wise and active co-Councillor. He was of great help to me when I became President in 1995. During my four years as President, the Geology Group was struggling and Jack, along with another recently deceased member, Professor Neil Archbold, helped to reactivate it.

In retirement, Jack spent much of his time in Warrnambool, continuing his work on fossil plants, as well as editing *The Nature of Warrnambool* (Warrnambool Field Naturalists Club Inc., 2004) which is used as a valuable resource by naturalists, students and tourists. At the time of his death he was working on a book titled *The Whales of Warrnambool* and was also President of the Warrnambool Field Naturalists Club.

His love of reading and writing, his thirst for learning, and storytelling reverberated with his audiences. Other pastimes included collecting firewood, fishing the southern shores, and playing with his grandchildren.

Cancer caught up with Jack in the last three years of his life. Despite this, he continued to play his regular Tuesday afternoon tennis with the 'sheilas' at the Warrnambool Lawn Tennis Club. The self styled 'Last Action Hero' passed away on the court from heart disease. Appropriately he won the point. Dr John Gordon George Douglas departed this world a legend in most things he attempted.

Anne Douglas,
with additional comments
from **Rob Wallis**

Notes on recruitment in *Sphacelaria biradiata* Askenasy (Sphacelariales, Phaeophyceae)

Sphacelaria biradiata (Fig. 1) is a small brown alga in the division Sphacelariales. It grows up to 30 mm in length and may be epilithic or epizoic but is mainly epiphytic on larger algae or seagrasses (Table 1). Its recruitment and dispersal were investigated in a rock pool on Glaneuse reef at Point Lonsdale, Victoria, to determine the distance that propagules travelled. Propagules are any structure that can develop into another plant. *Sphacelaria biradiata* can reproduce by vegetative propagules (Fig. 2), which are small deciduous branchlets, as well as by spores (Fig. 3) and fertilisation of gametes (Figs. 4 and 5).

Eleven tagged *Caulocystis uvifera* plants, the main host of *S. biradiata*, were attached to rocks and placed into a study pool (Fig. 6). Each *C. uvifera* plant comprised four to five stems completely devoid of *S. biradiata*. This was determined visually with the naked eye, but scrapings of selected stems, examined using a compound microscope, did not show any growths. Rocks were 30 - 50 cm in length, 15 - 50 cm in width and were up to 15 cm in height. The larger rocks required two people to move them. They were placed at various locations in relation

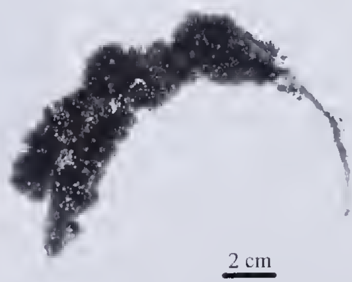


Fig. 1. *Sphacelaria biradiata* epiphytic on *Caulocystis uvifera*

Table 1. Frequency of *Sphacelaria biradiata* on hosts.

Host	Frequency
Acrocarpia sp.	moderate/common
Caulocystis uvifera	common
Cladostephus spongiosus	common
Dictyota dichotoma	rare
Halopteris paniculata	moderate/common
Halopteris pseudospicata	moderate/common
Hormosira banksia	rare
Notheia anomala	rare
Sargassum muticum	common
Zonaria angustata	rare
Zostera muellerir	rare

to established *S. biradiata* (Fig. 6) and the availability of rock crevices in which to wedge them. By the end of the study period (May to August) only one plant remained; the other 10 had been washed away in storms. This plant was one metre from the nearest *C. uvifera* with established *S. biradiata*, and had been successfully colonized by *S. biradiata* by the end of the study period. No other epiphytes were present. The newly recruited *S. biradiata* had begun to develop vegetative propagules (Fig. 3), but had not developed sporangia or gametangia, so it was not determined whether plants were sporophytic or gametophytic.

Another method used to determine dispersal distance of propagules is to sample the water column for spores, gametes or vegetative propagules, so one litre depth integrated water samples were taken from the vicinity of the relocated *C. uvifera* each month, transported back to the laboratory on ice in a dark refrigerated container and examined immediately. Spores and gametes congregate at the water's surface and are positively phototactic, i.e. swim towards the light. A light was directed onto one side of the bottles of seawater for three to five minutes in an attempt to concentrate spores. Three samples were taken from this region with a pipette, placed on a slide and examined under a compound microscope.

Fig. 2. Vegetative propagules of *Sphacelaria biradiata.*

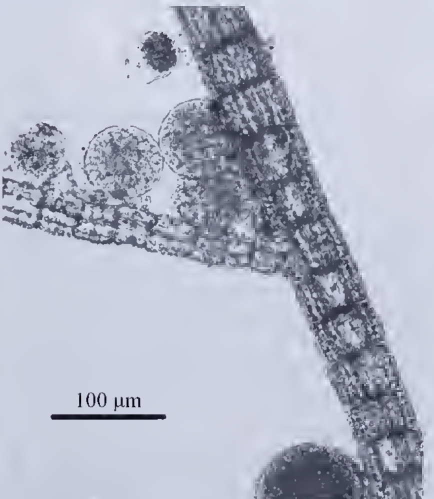


Fig. 3. Unilocular sporangia on *Sphacelaria rigidula*. Sporangia contain spores, which can germinate and develop into new plants.

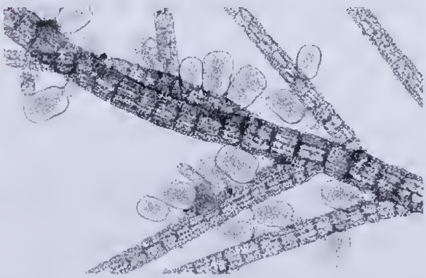


Fig. 4. *Sphacelaria biradiata* with gametangia containing male gametes.

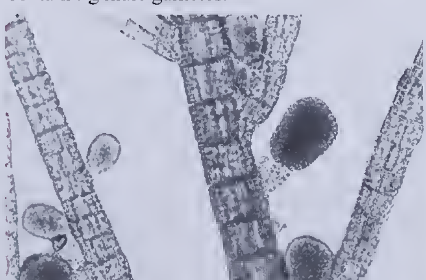


Fig. 5. *Sphacelaria biradiata* with gametangia containing female gametes.

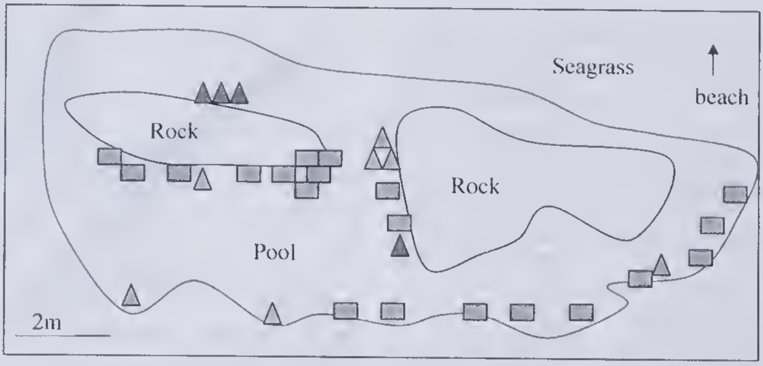


Fig. 6. Rockpool showing position of established *Caulocystis uvifera* (rectangles) with epiphytic *Sphacelaria biradiata* and position of relocated *C. uvifera* (triangles).

No spores were found, nor were gametes or propagules found throughout the rest of the water sample, although plants with sporangia (Fig. 4), gametangia (Fig. 5) and propagules occurred on plants of *S. biradiata* epiphytic on *C. uvifera* growing naturally in the study pool.

Although this study was essentially unsuccessful as all but one transplanted *C. uvifera* were washed away, it did show that the use of natural substrata for recruitment studies of epiphytes is possible. Few recruitment studies have been conducted in Victoria, with none on epiphytes.

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Studies on Victorian bryophytes 7. The genus *Triandrophyllum* Fulf. & Hatch.

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Abstract
Triandrophyllum subtrifidum (Hook.f. & Tayl.) Fulf. & Hatch. var. *subtrifidum* is known in Victoria from a single site, on the West Tyers River. The species is described and illustrated, and its conservation status is discussed. (*The Victorian Naturalist* **124** (1), 2007, 48-51)

Introduction

The genus *Triandrophyllum* was erected by Fulford and Hatcher (1959, 1962) as a segregate from *Isolembidium* R.M.Schust., and placed in the family Herbertaceae. The genus at present comprises five species, of which only *Triandrophyllum subtrifidum* (Hook.f. & Tayl.) Fulf. & Hatch. var. *subtrifidum* is known to occur in Australia. It has been reported from one locality on Mt Wellington in Tasmania and recently from one locality on the West Tyers River in Victoria. The type was collected by JD Hooker from an unknown locality in Tasmania, possibly Mt Wellington. The distribution extends to New Zealand (Allison and Child 1975; Glenny 1998) and to much of Andean South America, where *Triandrophyllum subtrifidum* (Hook.f. & Tayl.) Fulf. & Hatch. var. *trifidum* (Gott.) Solari also occurs (Solari 1973; Engel 1978).

Description

Triandrophyllum subtrifidum (Hook.f. & Tayl.) Fulf. & Hatch. var. *subtrifidum*
Plants yellowish green, in turfs, shoots mostly unbranched, to about 40 mm long (Fig. 1). **Leaves** to about 1.5 mm long, imbricate to widely separated, bent strongly

Fig. 2. Habitat of *Triandrophyllum subtrifidum* var. *subtrifidum* (arrowed) in the West Tyers River.

to the ventral side of the stem, incubous, becoming larger towards the shoot apex; deeply divided into 2 or 3 lobes, the number of lobes apparently random; cells mostly isodiametric or slightly longer than wide, typically 25–35 µm wide in mid-leaf but longer (to about 2 x 1) in the leaf base and smaller and squarer on the leaf margins, with thick walls and small to medium trigones. **Underleaves** similar to the leaves but slightly smaller, to about 1 mm long, spreading from the stem at a small to large angle; cells similar to those in the leaves. **Oil bodies** ± globular, of grape-cluster type, slightly brownish in transmitted light, 0–several per cell. **Surfaces** of stem, leaves and underleaves striolate, the striolae becoming shorter in the leaf and underleaf lobes. Androecia and gynoecia not seen.

Habitat: Generally, on soil in damp or boggy situations in montane to alpine areas. In West Tyers River, on soil in niches on a boulder in the river at about 730 m asl (Fig. 2).

Known distribution: Tasmania, Victoria (Fig. 3); also New Zealand, South America.

Similar taxa

Triandrophyllum subtrifidum outwardly resembles species of *Isotachis* Mitt., *Herberta* Gray and *Isolembidium*, and *Clasmatocolea inflexispina* (Hook.f. & Taylor) Engel. But species of *Isotachis* and *Herberta*, as well as *Clasmatocolea inflexispina*, have only 2-lobed leaves and underleaves, and *Isolembidium anomalum* (Rodw.) Grolle, known from Tasmania, has unlobed leaves and underleaves.

Triandrophyllum heterophyllum (Steph.) Grolle is a tropical species known from Java and New Guinea. It is a smaller plant with a purplish tinge, and the leaves are alternately 2-lobed and 3-lobed, with the lobe tips often ending in a uniseriate row of up to 4 cells (Piippo 1984). *Triandrophyllum symmetricum* Engel, known from a single site in New Zealand, has markedly symmetrical leaves and underleaves with 3 or 4 lobes, and the margins of the leaf bases are often armed with small teeth (Engel 1999).

Of the other South American taxa, *T. subtrifidum* var. *trifidum* has a few small spines on the margins of leaves and under-

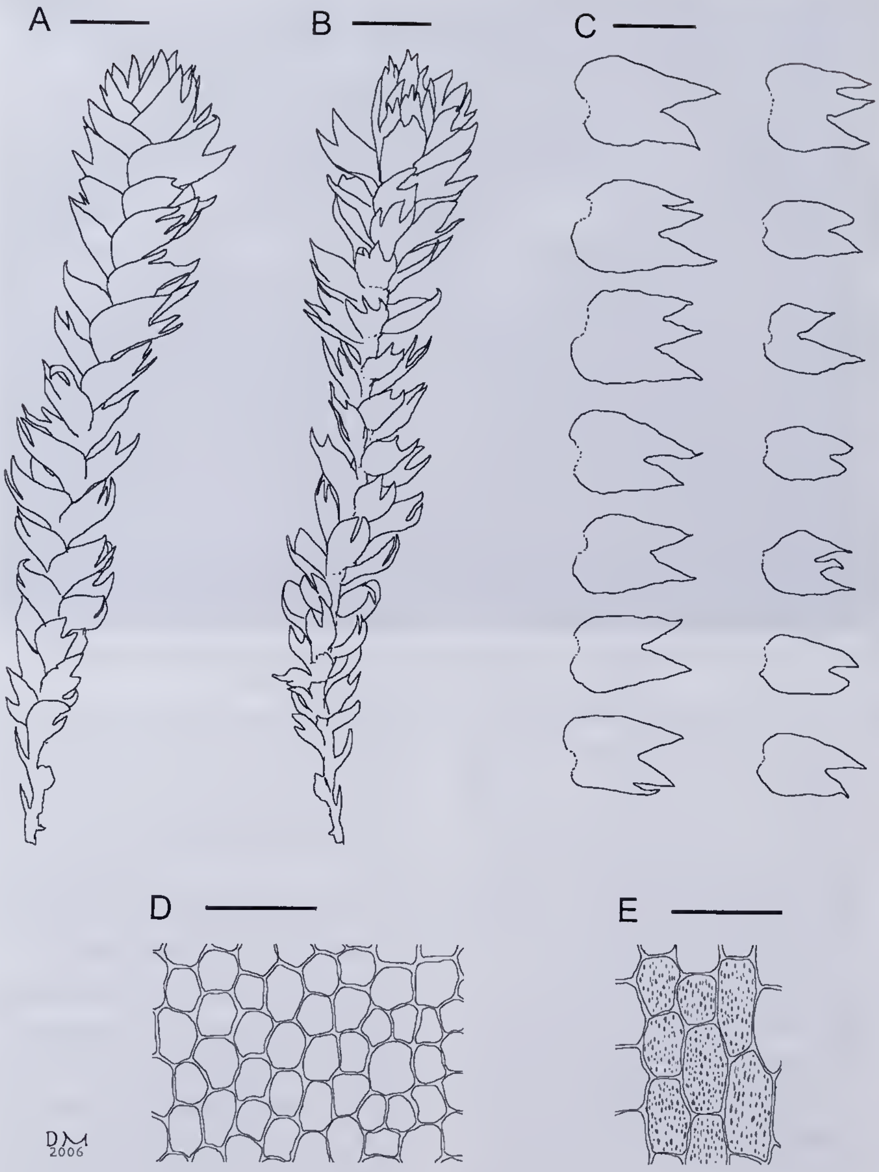

Fig. 1. *Triandrophyllum subtrifidum* var. *subtrifidum*. **A.** Moist shoot (dorsal view). **B.** Moist shoot (ventral view). **C.** Leaves (left) and underleaves (right). **D.** Cells in mid-leaf. **E.** Cells in leaf base, showing striolae. Scale bars: A–C = 1 mm, D–E = 100 µm. All drawn from Meagher 06-011 (MELU).

leaves, *T. fernandeziense* (S. Arnell) Grolle ex Fulf. & Hatch. has very spiny underleaves and a few spines on the leaf margins, and *T. georgiense* (Steph.) Fulf. & Hatch. has constantly 2-fid leaves and underleaves (Fulford 1963).

Conservation status

A search in Australian herbaria for *Triandrophyllum subtrifidum* among other species that might be confused with it found no additional collections. It therefore appears to be extremely rare in Australia.

The Victorian site is within Tanjil State Forest, Special Protection Zone 481/01 (DSE 2004), in a Rainforest Site of Significance CH30 (Peel 1999). The construction of a road bridge over the West Tyers River, close to the site, could have an impact on the population, as well as populations of two other significant bryophytes at the site, *Calomnion complanatum* (Hook.f. & Wilson) Lindb. (listed as threatened under the Victorian *Flora and Fauna Guarantee Act 1988*) and *Treubia tasmanica* R.M.Schust. & G.A.M.Scott (a very rare species in Victoria; DSE 2006).

Under the existing IUCN guidelines for assessing the conservation status of bryophytes (Hallingbeck et al. 2000), *Triandrophyllum subtrifidum* var. *subtrifidum* should be classified as VU (vulnerable) in Victoria and Australia (criterion D, subcriteria D1 and D2). At the time of writing it had been nominated for listing as a threatened species in Victoria under the Flora and Fauna Guarantee Act.

Acknowledgements

Many thanks to Neville Scarlett, Bruce Fuhrer and John Eichler for organising a field trip to the West Tyers River on which *Triandrophyllum subtrifidum* was found. Thanks also to Judith Curnow, Australian National Botanic Gardens, Canberra, for organising the loan of material from the ANBG herbarium.

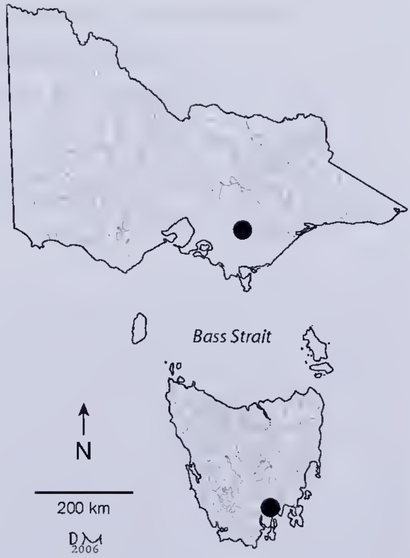

Fig. 3. Known distribution of *Triandrophyllum subtrifidum* in Australia.

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Distribution, frequency and density of the weed *Achillea millefolium* Yarrow in the Snowy Mountains, Australia

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Abstract

This paper examines the distribution of Yarrow *Achillea millefolium* L. (Asteraceae), in the Snowy Mountains. Location data from species specific surveys, field experiments and 18 general vegetation surveys were mapped in relation to altitude/floristic zone, climatic parameters (rainfall and temperature) and location of roads and tracks. *Achillea millefolium* is less common with increasing altitude and benefits from human disturbance. Using all location data, Yarrow was found at 376 sites; nearly all associated with human disturbance (91% of sites) mostly road or trail verges (72%) and around buildings and other ski tourism infrastructure. It occurred along ~100 km of public access roads, management trails and walking tracks, from the tableland to the alpine zone (800 m to 2100 m altitude). The general vegetation surveys, however, indicate that although it can be found in 15% of disturbed sites, it is uncommon in undisturbed vegetation (4%). Yarrow occurred at high density around buildings and low density along walking tracks in the species specific surveys. The distribution of *A. millefolium* demonstrates that human disturbance provides favourable habitats for weeds even in mountains. Although its distribution was affected by altitude, *A. millefolium* was able to establish and grow on some of the highest mountains in Australia, along tracks. Increased disturbances as well as climate change are likely to facilitate its spread. (*The Victorian Naturalist*, **124** (1), 2007, 52-63)

Introduction

Distribution boundaries of plants are limited by biotic and abiotic factors (Booth *et al.* 2003). Abiotic climatic characteristics such as temperature, precipitation and wind together with light, soil, nutrients, habitat disturbance and species specific characteristics are the major ecological determinants of distribution and abundance of plants (Swincer 1986; Crawley 1987; Cronk and Fuller 1995; Booth *et al.* 2003). As altitude increases, so does the severity of conditions, limiting the species richness of plants including exotics (Körner 2002; Grytnes 2003; Pauchard and Alaback, 2004; Becker *et al.,* 2005; Parks *et al.,* 2005). Plant establishment, growth and reproduction can be limited by decreased temperatures, increased risk of climatic events such as frosts and increased duration of snow cover (Billings and Mooney 1968; Green and Osborne 1994; Körner 1999; Costin *et al.* 2000).

In the Snowy Mountains, Australia, plants in the montane zone (500-1500 m asl) experience intermittent snow cover, and the temperature does not often fall below 0° C (Good 1992). In the subalpine zone (1500–1830 m asl) plants can experience snow cover for one to four months per year and minimum temperatures below freezing for around six months per year (Brown and Millner 1989; Green and Osborne 1994). In the alpine zone (1830–2228 m) plants experience snow cover for at least four months per year with increased risk of frosts, even in summer (Green and Osborne 1994; Costin *et al.* 2000). As a result of the increasingly difficult conditions many native plant species are unable to establish, grow and reproduce at higher altitude sites. The same seems to apply to exotic taxa, with decreasing richness and abundance of exotics with increasing altitude in the Snowy Mountains (Mallen-Cooper 1990; Johnston and Pickering 2001; Godfree *et al.* 2004; McDougall *et al.* 2005; Bear *et al.*, in press).

Alteration of the habitat by human disturbance can also affect the ability of exotics to establish, with disturbance to native vegetation often favouring exotics (Hobbs 1987, 1989; van der Valk 1992; Lozon and MacIsaac 1997; Booth *et al.* 2003). For example, in the Snowy Mountains there is a strong association between exotics and human disturbance, with most exotics occurring along roadsides and around buildings (Costin 1954; Mallen-Cooper 1990; Johnston and Pickering 2001;

Sanecki *et al.* 2003; Godfree *et al.* 2004; Bear *et al.*, in press).

Of the more than 175 species of exotic vascular plants in the Australian Alps, nine have been identified as of particular concern because of their potential to invade native vegetation. The species considered to be a high threat are *Cytisus scoparius* (Scotch Broom) and the three species of willow, *Salix fragilis, S. cinerea* and *S. nigra*. A further five species considered to be a serious threat to the subalpine and alpine floral communities in the Australian Alps are *Rubus discolor* (Blackberry), *Rosa rubiginosa* (Sweet Briar), *Nassella trichotoma* (Serrated Tussock), *Hypericum perforatum* (St. Johns Wort) and *Achillea millefolium* (Coyne 2003).

Achillea millefolium is a perennial herb native to Europe and Asia, with its distribution extending from the Mediterranean region to northern Iran to the Arctic Circle (Harden 1990-1993, Zhang *et al.* 1996). It has also been found in the southern hemisphere, including New Zealand and Australia, where it was introduced as fodder, as an ornamental and for its utility in herbal medicines. In temperate New Zealand *A. millefolium* is a major weed in mixed cropping farms, particularly in white clover, peas, beans, beets and other root crops (Bourdôt *et al.* 1979; Bourdôt and Butler 1985; Bourdôt *et al.* 1985; Bourdôt and Field 1988). Although often sold in nurseries in Australia, *A. millefolium* is regarded as an environmental weed in several States (Anon 1998; McDougall and Appleby 2000; Blood 2001) and has been documented as an environmental weed in the Australian Alps (Sainty *et al.* 1998).

Achillea millefolium is a weed in many cold, temperate and Mediterranean climates, often in agricultural land (Bourdôt *et al.* 1979; Holm *et al.* 1979; Warwick and Black 1982). It has a long flowering period with large numbers of viable seed produced each season (Bourdôt *et al* 1979; Warwick and Black 1982; Henkens *et al.* 1992). The rhizome system contains a large number of dormant buds that can produce daughter plants upon rhizome fragmentation (Bourdôt *et al.* 1979; Henkens *et al.* 1992).

Although recorded as early as 1949 in grasslands in the subalpine zone of the Snowy Mountains (NSW Soil Conservation Herbarium database; Costin 1954), populations of *A. millefolium* appear to have increased rapidly during the 1990s (Sanecki *et al.* 2003). The increase is possibly associated with the use of gravel from weed-contaminated dumps in the construction and maintenance of roads and other infrastructure (R. Knutson pers. comm. NSW National Parks and Wildlife Service, 1999). In recent surveys *A. millefolium* was recorded along roadsides and in drainage areas in subalpine zone of the Snowy Mountains with plants present in native vegetation 10 m from the road verge.

This paper assesses the distribution of *A. millefolium* in the Snowy Mountains using data from species surveys and field experiments, and 18 general vegetation surveys. The associations of *A. millefolium* with roads and abiotic factors (altitude, temperature and rainfall) were assessed using geographic information system (GIS) software and the NSW National Parks and Wildlife Service GIS database.

Methods

Location records of Achillea millefolium

Three sources of location data were used to estimate the distribution of *A. millefolium* within the southern and central sections of the Snowy Mountains. Firstly, specific surveys of *A. millefolium* were conducted along selected roads and around other infrastructure. Secondly, location data were obtained during a series of field experiments examining the phenology of *A. millefolium* (Johnston 2005), resource allocation (Johnston and Pickering 2004) and seed ecology of *A. millefolium* (Johnston 2005) in the Snowy Mountains. These sources are referred to as *A. millefolium* specific records/surveys. Thirdly, location records for *A. millefolium* were selected from a database of records of exotics from 18 general vegetation surveys of 499 sites conducted between 1986 and 2004 in the Snowy Mountains (Bear *et al.* in press).

Achillea millefolium *specific surveys/records*

Between January and March in 1999 and 2000, sites were surveyed for the presence of *A. millefolium* approximately every two km along the major public access roads (Kosciuszko Road, Alpine Way and the Snowy Mountains Hwy), selected sec-

ondary roads (Guthega Road, Link Road, Island Bend Road and the Summit Road) and selected management trails (Cascade trail, Schlinks Pass Road and Valentine Fire Trail). In addition, disturbed areas around buildings at ski resorts (Smiggin Holes, Perisher Valley and Thredbo Village) and other infrastructure such as huts, toilets and picnic grounds were surveyed for *A. millefolium*.

The precise locations of *A. millefolium* were recorded and an estimate made of site-specific cover/abundance. At infrastructure sites such as solitary huts a single assessment was made of cover/abundance. Cover/abundance was estimated on a six level scale (Low = isolated plants < 5 cm^2 in size. Medium Low = isolated plants > 5 cm^2 in size. Medium = discontinuous cover with distinct gaps between plants, area covered between 5 cm^2 and 30 cm^2. Medium High = discontinuous cover with distinct gaps between plants, area covered between 30 cm^2 and 50 cm^2. High = continuous cover, area covered between 50 cm^2 and 70 cm^2. Very High = continuous cover, areas greater than 70 cm^2 in size.) In these surveys *A. millefolium* was found at 300 sites in the Snowy Mountains.

Location records of Achillea millefolium *from database of vegetation surveys*

Location records of *A. millefolium* were selected from a database of records of exotic species in The Snowy Mountains, from 18 general vegetation surveys conducted between 1986 and 2004 (Bear *et al.* in press). This database included 1103 records of 154 exotic taxa from 363 sites with exotics. It also included data on 136 sites where exotics were not found in vegetation surveys, giving a total of 499 sites. Sources of vegetation survey data included published research papers, PhD and Honours theses, New South Wales National Parks and Wildlife Service reports and unpublished research by members of the School of Environmental and Applied Sciences, Griffith University (Table 1). Each exotic taxon record had information on its spatial coordinates, vegetation zone, altitude, vegetation community or anthropogenic disturbance type. Sites were considered disturbed if they were highly likely to have experienced vegetation removal and alteration to soils during construction and use of infrastructure, e.g. sites were defined as disturbed if they were located on the verges of tracks, roads or in the immediate area around buildings, dams etc. Sites were considered natural if they were in areas away from infrastructure and had no other signs of human activity/use.

Mapping the distribution of Achillea millefolium

Using the location records of *A. millefolium* from (1) the specific surveys, (2) the experiments and (3) the 18 general surveys, the distribution of *A. millefolium* in Kosciuszko National Park was mapped in relation to altitude/floristic zone (alpine = ~1850 m to 2228 m; subalpine = ~1500 m to ~ 1850 m and montane = ~1500 to 500 m), climatic parameters (mean annual rainfall and average temperature) and location of roads and tracks using data from the NSW National Parks and Wildlife Service geographic information system (GIS) database and ESRI ArcVIEW GIS software. The locations of 319 sites from the 18 general vegetation surveys where there were exotics other than *A. millefolium* were also mapped to indicate the geographic range of exotics in Kosciuszko National Park. The locations of the 136 sites in the 18 general vegetation surveys where there were no exotics were also mapped.

Results

From the *A. millefolium* specific surveys, field experiments and general vegetation surveys there was a total of 376 sites with *A. millefolium* in the southern and central sections of the Snowy Mountains (Table 2). There were an additional 323 sites that contained exotics other than *A. millefolium* and 136 sites where only native taxa were found.

Altitude and climate

Achillea millefolium was recorded in tableland, montane, subalpine and alpine zones (800 m – 2100 m) with 85% of sites in subalpine and montane areas (Fig. 1). The climate of these zones is consistent with areas of Australia that have been mapped as suitable habitat for *A. millefolium* (Johnston 2005). Based on the GIS maps of climatic variables the mean annual temperatures of most *A. millefolium* sites were relatively cool, ranging from 3° C to 9° C. Rainfall/

Table 1. Details of 18 general vegetation surveys conducted between 1986 and 2004 in montane to alpine zones of Kosciuszko National Park, Australia.

Data source	Floristic zone, vegetation type and disturbance type
Hill W and Pickering CM. Effect of drought and fire on alpine and subalpine vegetation in Kosciuszko National Park: severity of initial impact & predictions for recovery. Unpublished data.	1. Alpine & subalpine zone 2. Natural tall alpine herbfield, windswept feldmark, heath and subalpine grassland burnt in 2003 bushfires and nearby natural unburnt vegetation.
Pickering CM, Growcock A, Hill W, Banks J and Field J Long Plain, Kosciuszko National Park disturbed through prior grazing. Unpublished data	1. Montane zone 2. Woodland and grassland disturbed by livestock grazing practices (>40 years previously)
Pickering CM, Growcock A, Hill W, Banks J, Field J Long Plain Kosciuszko National Park. Unpublished data.	1. Montane zone 2. Natural woodland and grassland
Pickering C, Appleby M, Good R, Hill W, McDougall K, Wimbush D and Woods D (2002) Plant diversity in subalpine and alpine vegetation recorded in the Kosciuszko Biodiversity Blitz. In: *Biodiversity in the Mountains*. (ed. K Green). Australian Institute of Alpine Studies, Canberra.[1]	1. Alpine and subalpine zone 2. Natural tall alpine herbfield, heath, subalpine grassland and subalpine woodland. Disturbed areas in and around ski resorts including ski slopes.
Pickering CM, Growcock A, Hill W, Banks J and Field J Long Plain Transgrid Power lines. Unpublished data.[1]	1. Montane zone 2. Disturbed heath and grassland under powerlines
Hill W and Pickering CM (2006) Vegetation associated with different walking track types in the Kosciuszko alpine area, Australia. *Journal of Environmental Management*. **78**, 24-34.[1]	1. Alpine zone 2. Disturbed vegetation on verges of walking tracks and adjacent natural tall alpine herbfield.
Mallen-Cooper J (1990) Exotic plants in the high altitude environments of Kosciuszko National Park, southeastern Australia. PhD thesis, Department of Biogeography and Geomorphology, Research School of Pacific Studies, Australian National University, Canberra.[1]	1. Alpine, subalpine, montane and tableland zones 2. Disturbed road verge vegetation and nearby natural vegetation
Global Research Initiative in Alpine Environments GLORIA (2004 sampling). Unpublished data.	1. Alpine zone 2. Natural tall alpine herbfield and heath.
Bear Z and Pickering CM (2006). Recovery of subalpine grassland from bushfire: comparison of vegetation in burnt and unburnt paired plots one year post fire in the Kosciuszko National Park. *Australian Journal of Botany*. **54**, 451-458.	1. Subalpine zone 2. Natural tall alpine herbfield burnt in 2003 bushfires and adjacent unburnt tall alpine herbfield.
Campbell M (2004) Vegetation associated with the latest lying snowbanks in Australia. Honours thesis, School of Environmental and Applied Sciences, Griffith University, Gold Coast.	1. Alpine zone 2. Natural short alpine herbfield and tall alpine herbfield
Scherrer P (2003a) Ch 4 Long term vegetation transects in the Kosciuszko alpine zone. In: Monitoring vegetation change in the Kosciuszko Alpine Zone, Australia. PhD thesis, School of Environmental and Applied Sciences Griffith University, Gold Coast.	1. Alpine zone 2. Natural tall alpine herbfield
Scherrer P, Wimbush D and Wright G (2004) The assessment of pre and post 2003 wildfire data collected from subalpine transects in Kosciuszko National Park. Report for the Department of Environment and Conservation, National Parks and Wildlife Division.	1. Subalpine zone 2. Natural subalpine grassland and heath
Growcock A (2005) Trampling impacts in Kosciuszko National Park, Australia. PhD thesis, School of Environmental and Applied Sciences, Griffith University, Gold Coast.	1. Alpine and subalpine zone 2. Natural tall alpine herbfield and subalpine grassland
Scherrer P and Pickering CM (2005) Recovery of alpine vegetation from grazing and drought: Data from long term photoquadrats in Kosciuszko National Park, Australia. *Arctic, Antarctic and Alpine Research* **37**, 574-584.	1. Alpine zone 2. Natural tall alpine herbfield

Table 1 cont'd

Data source	Floristic zone, vegetation type and disturbance type
Scherrer P and Pickering CM (2006) Recovery of alpine herbfield on a closed walking track in the Kosciuszko Alpine Zone, Australia. *Arctic, Antarctic and Alpine Research* **38**, 239-248.[1]	1. Alpine zone 2. Disturbed tall alpine herbfield on rehabilitated walking track 15 years ago and adjacent natural tall alpine herbfield.
Johnston F (2005) Ch 5 In: Exotic plants in the Australian Alps including a case study of the ecology of *Achillea millefolium* in Kosciuszko National Park. PhD thesis, School of Environmental and Applied Sciences Griffith University, Gold Coast.[1]	1. Subalpine zone 2. Disturbed road verge vegetation and nearby natural subalpine grass land.
Bear Z and Pickering CM. Impacts of fire on road verge vegetation and adjacent natural areas (unpublished data).[1]	1. Subalpine zone 2. Disturbed road verge vegetation and adjacent natural grassland.
Johnston F and Johnston SW (2004) Impacts of road disturbance on soil properties & on exotic plant occurrence in subalpine areas of the Australian Alps. *Arctic, Antarctic & Alpine Research* **36**, 201-207.[1]	1. Subalpine zone 2. Disturbed road verge vegetation and adjacent natural subalpine grassland vegetation.

[1] Survey examined effect of anthropogenic disturbance on vegetation, therefore more likely to record exotic species.

Table 2. Number of sites where *Achillea millefolium* was recorded by location type in the Snowy Mountains. (Sources: *A. millefolium* specific surveys and experiments and 18 general vegetation surveys.

Location type	**# sites**	**Sites with *A. millefolium* (%)**
Infrastructure	44	11.7
Main road	104	27.6
Secondary road	115	30.5
Management trail	55	14.6
Walking track	26	6.9
Native vegetation	32	8.5
Total	**376**	**100**

snow in these sites was high, ranging from 1201 to 2500 mm of precipitation per year (Figs. 2 and 3). Most *A. millefolium* sites were in sites that had clear evidence of human disturbance (91.5%) particularly along the verges of roads and management trails in the subalpine and montane zones and at landfill sites at lower altitudes in the tableland zone (Fig. 1; Table 2).

The highest altitude site at which *A. millefolium* was recorded was 2100 m on Mount Twynam, 7 km from the highest mountain in continental Australia (Mt Kosciuszko 2228 m) where it was growing in the eroded wheel tracks of an old management trail (Fig. 4).

Human disturbance

The distribution of *Achillea millefolium* was strongly associated with anthropogenic disturbance, particularly roads and infrastructure (Table 2, Fig. 1). The Snowy Mountains is dissected by roads, tracks and clearings producing an extensive network of edges. It was estimated that there are 1212 km of public access roads, 1238 km of management trails and 192 km of walking tracks (source: New South Wales National Parks and Wildlife Service GIS database).

Of the 376 sites at which *A. millefolium* was recorded 91% were in areas affected by human disturbance. This exotic was recorded along more than 100 km of walking tracks, public access roads and management trails in the Snowy Mountains – 104 sites along main roads, 115 sites on secondary roads, 55 on management trails, 26 on walking tracks and 44 around other types of infrastructure (ski resorts, rangers' stations, sewage works and power stations, Fig. 1). *Achillea millefolium* was recorded in only 32 sites where vegetation was classified as natural.

There are two major sealed access routes to the southern section of the Snowy Mountains, the Kosciuszko Road between Jindabyne and Charlotte Pass and the Alpine Way from near Jindabyne to Khancoban (Fig. 1). Along the Kosciuszko Road *A. millefolium* plants were found from the boundary of the montane/subalpine zone (Sawpit Creek) to Charlotte Pass in the high subalpine zone. In some areas along this road plants were also

Fig. 4. *Achillea millefolium* flourishing at high altitude in the eroded wheel tracks of an old management trail on Mt Twynam (2010 m). Rhizomes are encroaching into adjacent natural vegetation burnt in the 2003 bushfires (Photos: S Johnston January 2005).

found in adjacent native vegetation. Along the Alpine Way populations were found from the entrance to the Park (tableland zone) through to Thredbo Village and onto Pilot Lookout (Fig. 1).

Achillea millefolium populations were also common along verges of minor sealed and unsealed roads, including the Guthega Road between the Guthega Power Station and Schlinks Pass road. Populations of *A. millefolium* were found growing along Schlinks Pass road through to Disappointment Spur with large monoculture populations found at the Disappointment Spur aqueduct. Populations were found along the following minor roads and management trails: the Cascade Trail, Pilot Lookout Trail, Farm Creek, Snow Ridge Road, Goat Ridge Road, Link Road, King Cross Road, Ridge Four Wheel Drive Trail, Valentine Fire Trail, minor roads within the Island Bend Road complex, Swampy Plain Bridge Road, and Rock Creek trail (Fig. 1). *Achillea millefolium* was also along management trails through the Jagungal Wilderness area.

Although currently uncommon in the alpine zone, there are isolated plants and small populations along the Summit Road, the Blue Lake walking track, the Main Range walking track and around Seaman's Hut near Mount Kosciuszko (Sanecki *et al.* 2003). Of particular concern is a population on a disused track on Twynam Ridge (2100 m, Fig. 4) which has increased substantially since the 2003 bushfires. In 1999 *A. millefolium* covered an area of ~20-40 m^2 on the track: January 2005 the area covered by *A. millefolium* was around 160 m^2 although this was discontinuous cover (Fig. 4). It appears to be spreading into adjacent subalpine grassland vegetation burnt in the 2003 fires (Johnston pers. obs.).

Other disturbed areas with *A. millefolium* include those surrounding infrastructure, such as the ski resorts, rangers' stations, sewage works and power stations (Fig. 5). Locations with large populations of *A. millefolium* included Perisher Valley, Smiggin Holes, Guthega Village, Cabramurra, Selwyn, Thredbo, Kiandra, Old Kiandra Goldfields, Island Bend, Guthega, Perisher, Wilson's Valley, Sawpit Creek, Falls Creek and Charlotte Pass. In some of these areas, dense monocultures of *A. millefolium* were recorded. For example, *A. millefolium* was seen

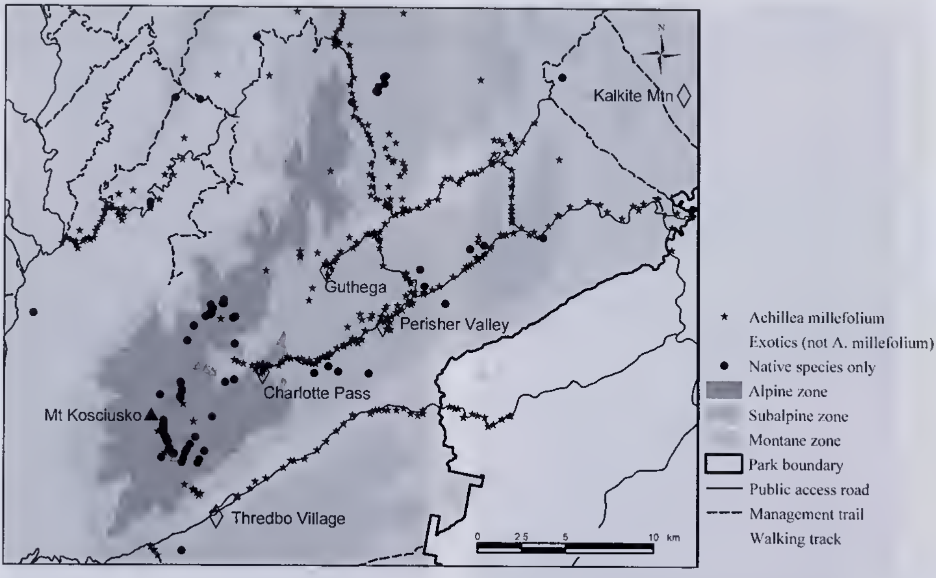

Fig. 1. Distribution of *Achillea millefolium* in relation to altitude/floristic zone in the Snowy Mountains based on 376 sites with *A. millefolium*. Sites that were surveyed but did not contain *A. millefolium* but either other exotics or only natives also were included to show the extent of sampling.

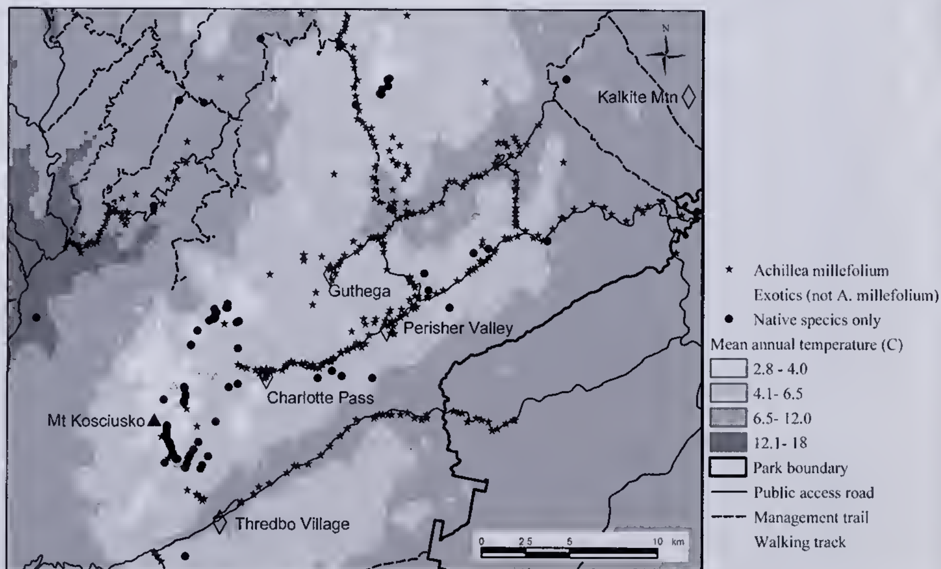

Fig. 2. Distribution of *Achillea millefolium* in relation to mean annual temperature (°C) in the Snowy Mountains. Sites not containing *A. millefolium* but containing other exotics or only natives are included to indicate the total distribution of sites.

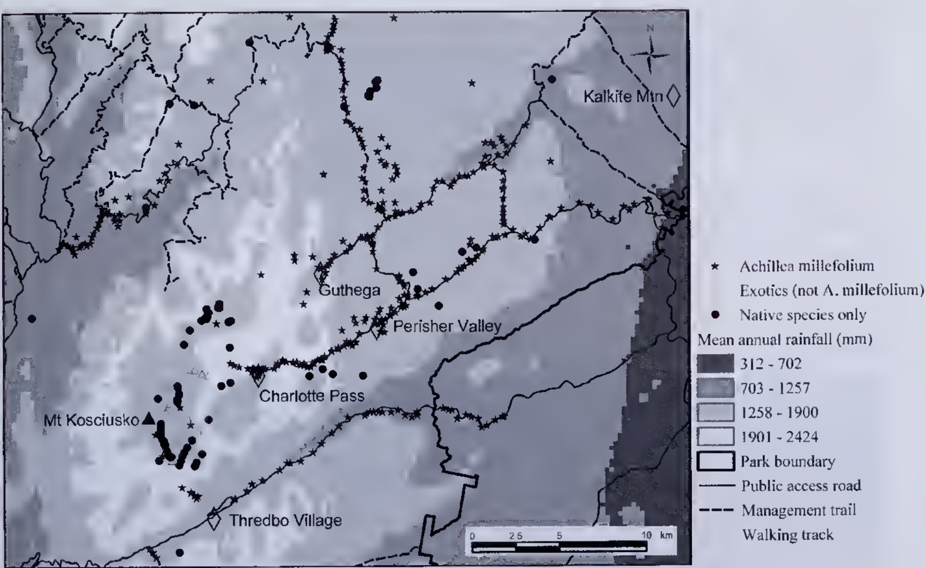

Fig. 3. Distribution of *Achillea millefolium* in relation to mean annual rainfall (mm) in the Snowy Mountains. Sites that were surveyed but did not contain *A. millefolium* but contained either other exotics or only natives also were included to show the extent of sampling.

growing up to 39 m from the road verge (Johnston pers. obs.) in outwash areas from a culvert opposite a ski lodge and ski lift in Perisher Valley.

Achillea millefolium *in natural vegetation*
Although most common in disturbed areas, *A. millefolium* grows in a number of natural vegetation communities including short alpine herbfield, tall alpine herbfield, sod tussock grassland, subalpine woodland and tall heath associations (as defined in Costin 1954 and Costin *et al.* 2000, Fig. 6) (Johnston pers. obs.). For example *A. millefolium* plants were observed in subalpine grassland (*Poa* spp.) near Dicky Cooper Creek, where there were no obvious signs of recent disturbance (Johnston pers. obs). Along sections of the Geehi River *A. millefolium* was observed growing from the edge of the road down to the water edge (Johnston pers. obs.).

Frequency and density of* Achillea millefolium *in the Snowy Mountains
Although it is clear that there are many places in the Snowy Mountains where *A. millefolium* can be found there are also many disturbed and natural areas where it does not occur. Based on the general vegetation survey data, *A. millefolium* occurred in only 12% of all sites where exotics were recorded. In natural areas *A. millefolium* was even less common and was found in just 4% of sites with exotics (Bear *et al.* in press) (Table 3).

The cover/abundance of *A. millefolium* was estimated at 300 sites along primary roads, secondary roads, management trails and other infrastructure. Cover/abundance was highly variable and appeared to be associated with the degree of disturbance, including if sites were likely to receive runoff from the road/trail (Table 4, Johnston and Johnston 2004). At some road drainage sites, *A. millefolium* was observed spreading into surrounding natural vegetation (Fig. 6). At sites adjacent to infrastructure *A. millefolium* was always recorded at either medium high or very high cover/abundance. Along main roads cover/abundance was more variable as it was recorded at low values as well as medium high values. Along secondary roads and fire/management trails cover/abundance was quite high and less variable. Along secondary roads cover/abundance was recorded as between medium to medium high and along fire trails it was medium high. In contrast, where *A. millefolium* was recorded along

Table 3. Number of sites recorded in 18 general vegetation surveys in the Snowy Mountains between 1986 and 2004. Number of sites with *Achillea millefolium*, number of sites with other exotics, and number of sites where no exotics were recorded (i.e. natives only).

Zone	Vegetation	# sites with *A. millefolium*	# sites with other exotics	# natives only sites	Total # sites
Alpine	Disturbed	1	48	17	66
	Natural	0	72	98	170
Subalpine	Disturbed	26	58	0	84
	Natural	10	53	15	78
Montane	Disturbed	5	55	1	61
	Natural	2	33	5	40
Total		**44**	**319**	**136**	**499**

Fig. 5. *Achillea millefolium* growing in front of the Marritz Hotel in Perisher Valley Snowy Mountains (Photo: S Johnston 1999).

walking tracks, the cover/abundance was low (Table 3).

Discussion

Achillea millefolium is found from the tableland to the alpine zones of the Snowy Mountains with the majority of sites in the subalpine (57%) and montane (27%) zones. Nearly all sites with *A. millefolium* were areas where vegetation and soils have been affected by human disturbance (91%). Although the majority of *A. millefolium* sites were along main and secondary roads, the greatest density of *A. millefolium* was recorded around buildings. Where *A. millefolium* was found on walking track verges, it was at low density, probably reflecting the lower intensity of disturbance in these areas.

Achillea millefolium was not common in undisturbed vegetation and occurred in less than 4% of sites where other exotics were recorded in the general vegetation surveys (Bear *et al.* in press). Therefore *A. millefolium* appears to be principally a weed of sites around infrastructure, including in areas with high water and sediment wash and nutrient-rich soils (Johnston and Johnston 2004). However it may be starting to establish in natural vegetation where

Table 4. Number of sites with different cover/abundance of *A. millefolium* at selected roads and other infrastructure in specific surveys in the Snowy Mountains between January and March 1999 and 2000. Low = isolated plants < 5 cm^2 in size. Medium Low = isolated plants > 5 cm^2 in size. Medium = discontinuous cover with distinct gaps between plants, area covered between 5 cm^2 and 30 cm^2. Medium High = discontinuous cover with distinct gaps between plants, area covered between 30 cm^2 and 50 cm^2. High = continuous cover, area covered between 50 cm^2 and 70 cm^2. Very High = continuous cover, areas greater than 70 cm^2 in size.

Cover/ Abundance	Buildings etc # sites	Main road # sites	Secondary road # sites	Fire trail # sites	Walking track # sites	Total # sites
Low	2	20	1		15	38
Med/ Low	3	4	2	5	1	15
Medium	3	20	30	14	7	74
Med/High	14	24	68	36	1	143
High	3	4	6		2	15
Very High	11	2	3			16
Total	**36**	**74**	**110**	**55**	**26**	**301**

Fig. 6. Population of *Achillea millefolium* growing between eroded wheel tracks and in adjacent grassland vegetation in a subalpine area of the Snowy Mountains. The highest density appears at the lowest point of the road where greatest water and nutrient wash off occurs. *Achillea millefolium* also appears to be spreading out from the road into surrounding vegetation (Photo: Z Bear 2004).

it can be difficult to remove once established (Sanecki *et al.* 2003).

The distribution of plants is determined by both abiotic and biotic factors (Booth *et al.* 2003). The spread of a plant begins with the removal of dispersal barriers and/or the creation of suitable new habitats (Cousens and Mortimer 1995). From the distribution of *A. millefolium* in the Snowy Mountains, it appears that human activities have provided suitable habitat for its establishment and may have contributed to its spread. *A. millefolium* may not have reached the limits to its distribution in this area, as there are sites with characteristics similar to those where it has been found, which have not yet been colonised.

This species will continue to spread in the Snowy Mountains unless there is a successful control program. As the provision of infrastructure for tourism in the Snowy Mountains has created suitable habitat for

A. millefolium, there needs to be careful evaluation of alternatives to minimise its spread. This should involve limiting new infrastructure to already disturbed sites, selection of types of infrastructure that minimise disturbance (e.g. raised steel mesh walking tracks rather than gravel etc., Hill and Pickering 2006), and active ongoing rehabilitation of sites once they have been disturbed. This is particularly important under future climate change, which is predicted to increase the area of habitat suitable for *A. millefolium* in high altitude areas of the Snowy Mountains (Johnston 2005).

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One Hundred Years Ago

THE PLENTY RANGES IN EARLY SPRING.

by A.D. Hardy, F.L.S.

The Golden Wattle, *Acacia pycnantha,* seems to show a disposition to modify its foliage as the altitude of the habitat increases. The highland plants, which are generally more symmetrical and handsome, have mostly dull bluish coloured and often more pointed pyllodes as compared with the shining and dark green phylloded plants of the lowland. This blue-grey "bloom," such as is found on plums, grapes, &c., was also seen to be more pronounced on *A. dealbata* than on that species at a lower altitude, and the appropriateness of the comon name, Silver Wattle, is readily appreciated.

The foliage of *A. pycnantha* here and on other parts of the Dividing Range is much eaten by insects. I remember that in September, 1905 on the Black Spur, I searched over twenty trees for a single small branchlet with entire phyllodes, but failed, to such an extent had these trees been attacked. Here in June *A. pycnantha* was in bloom, but the development of the buds is slow, for in the report of the excursion in January, 1900, Mr. Barnard states this species was then already in bud.

From *The Victorian Naturalist* **XXIV**, p. 133, December 1907.